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JOURNAL OF GENETIC PSYCHOLOGY

Child Behavior, Animal Behavior, and Problems of Aging

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VOLUME 41—January-June, 1950

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AGE AND SEX DIFFERENCES IN WORKERS' PERCEPTIONS OF HAPPINESS FOR SELF AND OTHERS*[1]

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A. INTRODUCTION

In studies of perceptual stereotypy of aging, knowledge about the perception of others remains largely untouched. The epidemic enthusiasm for empirical explorations of interpersonal relations, interpersonal communication, and perception of others that Cronbach, in the book edited by Tagiuri and Petrullo (13, p. 353), has described as "interesting, statistically significant, and exasperatingly inconsistent" has had little impact on the study of the perception of others in aging. Kipnis (3) has studied changes in self-concepts in relation to perception of others. Rabin (10) has studied the perception of others, by adjusted and maladjusted subjects. Suinn (12) has reported on the relationship between self-acceptance and the acceptance of others and learning-theory analysis. In an article by Tharp on patterning in marriage (14), there are reports of studies on self-ratings and on ratings by others, as techniques in marriage research.

The volume by Tagiuri and Petrullo (13) has had definite influence. For example, Kogan and Shelton studied the images of "old people" and "people in general" (4), as well as beliefs about " old people" in older and younger samples (5). Secord and Berscheid (11) studied stereotypy and the generality of implicit personality theory as applied to attitudes toward colored people. Davis (1), in an aged population, determined the relationship of social preferability and self-concept. But, in studies that refer to perceptual stereotypy of aging, particularly on years of happiness in life, many authors accept uncritically Tuckman and Lorge's assumption (15) that expressed personal preferences are indices of stereotypy. In such studies, perception of others has been neglected.

In an article on "Ego in otherdom," which appeared in *The Yale Review*, de Jouvenal (2) contends that the very stuff of life consists of Ego coming

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[1] Based on material prepared for presentation before Division 20 program on Personality Change and Age at 1963 APA Meeting. The study was sponsored by the Human Relations Research Foundation.

to terms with Otherdom; that the all-important power in life is that of Otherdom—not government. De Jouvenal states that Otherdom exists subjectively and is differentiated from society which, according to sociologists, has an objective existence. "My Otherdom," de Jouvenal says, ". . . is exactly congruous with no one else's Otherdom."

By obtaining reactions of workers to their impressions of others as well as to self, we may be in a position to study stereotypy in self and others; also, to explore facts about the degree of self that one reads into others.

B. Problem

A pilot study of worker's perceptions, in which workers were asked to rank five periods of life for happiness (8), indicated that worker's attitudes toward periods of years in their own lives do not always coincide with their notions of periods of life for other people, or with what they consider as characteristic of periods of time in "average" lives. In the pilot study, no attempt was made to measure the degree of stereotypy or to obtain sex differences. For earlier studies by the author, see (6, 7, 8, 9).

In the present study, the author investigated perceptual stereotypes about happy years for women in industry, as well as for men. Expressed as hypotheses, the questions investigated were as follows: (*a*) perception of years of happiness in life differs for self and others; (*b*) perception of years of happiness for others is more consistent and a more reliable index of stereotypy than perception of happiness for self; (*c*) for happiness of others, generally, younger years are more favored than later years; the oldest years are the least favored; (*d*) in perception of years of life that are happy for self, personal experience plays a differential role; (*e*) in perception of years for self, women tend to be more varied than men; (*f*) in accord with society's notion of male and female roles, men and women differ on reasons given for designating certain years as the happy years of life.

C. Method and Subjects

Subjects of this study were 270 employees (of one company) who worked in three different regions of the United States: Northeast, Midwest, and Far West. One-hundred-eighty of the subjects were men, 90 were women. Ages ranged from 17 to 62 for women and 17 to 64 for men. For all workers, the age distribution had a mean of 34.4 years and a standard deviation of 11.3. For male subjects, the age distribution had a mean of 33.7 and a standard deviation of 11.8. For female subjects, the age distribution had a mean of 36.0 and a standard deviation of 10.1

Data were obtained at departmental meetings. On special forms, subjects were instructed to review the spans of years indicated and to rank the spans in order as they felt them to include the best years of life for self. The best span of years was to be marked "1"; the next best span of years was to be marked "2"; and so on to the poorest span, which was to be marked "5." A second ranking was to indicate how subjects felt other people would rank each span of years. The subjects were also asked to write their reasons for their selection of the best and poorest years.

D. Results

1. *Age Preferences for Self and for Others*

Table 1, shows the mean rank order of each of five age groups, as rated by members of each age group.

TABLE 1
Mean Ratings of Happiness for Self and Others
($N = 270$)

Ages rated	Up to 20		20 to 35		35 to 45		45 to 60		60 and up	
	Self	Others	Self	Others	Self	Others	Self	Others	Self	Others
Up to 20	1.43	1.78	2.18	1.76	2.43	1.86	2.47	1.60	2.33	1.33
20-35	1.93	2.00	1.64	1.90	2.07	1.90	2.26	2.14	1.83	2.17
35-45	3.14	2.64	2.69	2.85	2.38	2.71	2.72	2.88	3.67	3.17
45-60	4.07	4.00	3.81	3.78	3.49	3.76	3.02	3.60	3.50	4.17
60 and up	4.43	4.57	4.67	4.72	4.64	4.76	4.44	4.77	3.67	4.17
W	.68	.61	.60	.64	.45	.63	.29	.62	.29	.62

The period from 20 to 35 years of age is the period rated happiest for self by all age groups, except by those under 20 and by those in the "35 to 45" group. At most ages, subjects rate the age period "20 to 35" as the happiest period of life. Next happiest is the "up to 20" period. Then, except for the "35 to 45" period, as age increases, rated happiness declines.

For each rating group, the last row in Table 1 shows the coefficient of concordance, W, a measure of degree of agreement among judges (16). A large W indicates a high degree of agreement; a small W indicates a low degree of agreement. When, as in this study, there are a large number of judges ($N = 270$), W is approximately equivalent to the average intercorrelation among judges. For perception of happy years in others, W is .60 or higher for every age group. For perception of happy years in self, the coefficient of concordance for self exhibits a downward trend with increase in age. From .68, for the "up to 20" group, W drops to .29 for the "45 to 60" group and remains at .29 for the "60 and up" group.

To test the statistical significance of the difference between ratings of happiness for self and others, the chi-square test was used.[2] Chi square was determined for ratings of happiness at each age span for self and for others. See Table 2. At the .01 or .02 levels of confidence, reactions toward self and others are significantly different: Happy years for others are judged to be different from happy years for self. As this conclusion causes one to question Tuckman and Lorge's use of expressed personal preference as an index of perceptual stereotypy (15), it is suggested that perception of others, rather than perception of self, be used as an index of stereotypy in studies of aging in industry.

TABLE 2
DIFFERENCES IN HAPPINESS RATINGS OF SELF AND OTHERS

Age group rated	χ^2	*df*	*p*
Up to 20	55.76	4	.01
20-35	22.22	4	.01
35-45	32.55	4	.01
45-60	12.28	4	.02
60 and up	22.24	4	.01

2. *Sex Differences in Age Preferences for Self and for Others*

When ranking age spans as to happiness, do women differ from men? The answer to this question is given by the data in Table 3.

TABLE 3
SEX DIFFERENCES IN MEAN RATINGS FOR SELF AND OTHERS

Ages rated	Ratings for self			Ratings for others		
	Men	Women	Total	Men	Women	Total
Up to 20	2.33	2.18	2.28	1.74	1.77	1.74
20-35	1.81	2.04	1.88	1.92	1.98	1.94
35-45	2.62	2.71	2.65	2.85	2.76	2.81
45-60	3.59	3.60	3.60	3.79	3.74	3.77
60 and up	4.64	4.49	4.59	4.72	4.76	4.72
W	.51	.43	.48	.64	.63	.63

On rating of happiness for self, Table 3 shows no sex differences, as far as rank order of age span is concerned. However, there are sex differences in coefficients of concordance. For men, ratings for self yield a coefficient of concordance of .51; for women, the coefficient is .43. The lower coefficient for women suggests that responses made by women are more varied than those made by men.

Based upon ratings made by women, as well as by men, the years rated as happiest for others is directly related to age. For others, the youngest years are rated as the happiest years; the oldest years are rated the least happy years. For others, the coefficients of concordance are higher than for self. Whether based on ratings made by men or women or both, coefficients of concordance for others are .60 or higher. For women as well as for men, ratings for others are more stereotyped than reactions to self.

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[2] Reference used for calculations was Walker and Lev (16, pp. 283-285).

3. *Sex Differences in Stereotypy*

For additional analysis, the author selected those ratings that were made by workers whose ratings for self were the same as their ratings for others. One-hundred-seventeen subjects (out of 270) made such ratings. Seventy-nine men (out of 180) and 38 women (out of 90) gave the same ratings for self as for others. The extent to which men differ from women in their selection of each of three age group preferences is indicated in Table 4.

TABLE 4
SEX DIFFERENCES IN STEREOTYPY AS INDICATED BY SELECTION OF SAME PREFERENCES FOR BEST YEARS FOR SELF AND OTHERS

			Per cent		
Age rated happiest	*N*	Total	Men	Women	Difference
Own age chosen	39	33.33	37.97	23.68	14.92
Younger age chosen	69	58.98	51.90	73.68	21.78
Older age chosen	9	7.69	10.13	2.64	7.49
Total	117	100.00	100.00	100.00	44.19

With sex as one variable and age grouping as the other variable, chi square for the data presented in Table 4 is 5.52, which is significant at the .10 level. To be significant at the .05 level, a chi square of 5.99 would be required. A study of the differences reported in Table 4 indicates the largest sex difference to be in "younger age chosen," a difference of 21.78. The next largest difference is in "own age chosen," a difference of 14.92 per cent. The smallest sex difference is on "older age chosen." It seems safe to infer that the significance indicated by the chi square derives largely from the sex difference in "younger age chosen."

The facts found concerning sex differences and age preferences in stereotyping can be summarized as follows: (*a*) The ratings of happiness in others is largely determined by age span in women as well as in men; from youngest to oldest is the sequence. (*b*) For ratings of self, there are no statistically significant sex differences in rank order of age spans. However, ratings assigned by women seem to be more variable than ratings assigned by men. (*c*) In workers whose ratings of self and others are the same, the largest sex difference is in "younger age chosen."

4. *Sex Differences in Reasons for Age Preferences*

In an article on expressed wishes of students (17), Wheeler reports sex differences in the United States as well as in Western Australia. Males, more than females, Wheeler found, make more wishes that involve money, vocation, and marriage. Female wishes, more often than male wishes, involve social relationships and benefits to parents, relatives, and others. Wheeler suggests that such differences are a function of the concepts of the male and female sex roles.

To see if comparable sex differences could be found in the ratings assigned by employed adults, reasons for the years rated happiest were classified in the most particularized fashion possible. Following a "particularized" classification, broader categories were assigned. The latter are given in Table 5. Two judges, who agreed on 80 per cent of the assignments made, classified all reasons in terms of the categories indicated in Table 5. Disagreements were resolved in conference by the two judges and the author. The final classification was the result of agreement among three persons.

TABLE 5

SEX DIFFERENCES IN REASONS FOR SELECTING YEARS AS BEST FOR SELF AND OTHERS

Reason	Self* Men	Self* Women	Per Cent Others** Men	Others** Women	Total*** Self	Total*** Others
Freedom from worry	21.43	28.57	31.43	50.80	24.81	40.60
Education	1.43	—	11.43	—	.75	6.01
Hope for fulfillment	7.14	1.59	1.43	1.59	4.51	1.50
Personal experience	5.71	15.88	12.85	14.28	10.53	13.54
Security and stability	17.15	7.93	10.00	11.11	12.78	10.53
Family affiliation	7.14	22.22	1.43	1.59	14.29	1.50
Self-acutalization	40.00	23.81	31.43	20.63	32.33	26.32

* Significant at the .01 level.
** Significant at the .10 level.
*** Significant at the .001 level.

Roughly, the categories in Table 5 are arranged (first to last) from those that involved the least responsibility to those that involve the most responsibility; i.e., from the most dependent to the most independent.

Responses that suggest lack of responsibility, a carefree attitude, and excitement and fun were classified under "Freedom from worry." Examples are, "Carefree, hardly any responsibility." "No responsibility and lots of fun." "Life was easy and when a person is young, things seem to be much more exciting." and "Freedom and no worries."

Examples of responses classified under education are as follows: "They get their education at this age, which is important for anyone." "They receive the greater part of their education and learn to get along with one another through sports and other social activities." "An age period in which one prepares for his future." "Get a good education and be ready for life." and "Better schooling."

Reactions classified under "hope for fulfillment" are reactions of people who still found themselves in a position to hope for what they were not getting; for example, a 27-year-old man selected as happiest the age span "20 to 35" because "I hope to find the key to the joy of living which I haven't found as yet." A 35-year-old man selected "60 and up" as happiest because "I would like to be as happy in those years as I have been in the others." He thinks others feel the same way. A 40-year-old woman selected "up to 20" as happiest for self because "When I was a child I still had faith that if I tried hard enough, my life would turn out well."

Responses classified under "personal experiences" include responses based on personal episodes of an ego-involved nature or projection onto others, because of personal involvement. Illustrative reactions are as follows: A 60-year-old man selected "up to 20" as happiest for self because "I had a better chance of getting better jobs at an age when I could enjoy them most." A 36-year-old man chose "up to 20" because "I was in the Air Force, saw lots of the country, went around the world, made lots of friends in service." A 43-year-old woman selected "45 to 60" because "I will have only myself to think of."

Responses under "security and stability" emphasize job stability and "settling down"; for example, "Well established and secure." "I have through experience become more secure in myself and have grown up." "When people reach 35-45, they have reached the point where they have what they want and are ready to settle down and save for the future." and "Situated in life and pretty settled."

Responses under "family affiliation" emphasize interpersonal relations, mostly toward or with members of the family. Illustrative reactions are as follows: "More good things have happened to me—I have my husband, my daughter and everything I could want for." "The responsibility of raising your children, enjoying your home life as well as your children and working for them." "Getting married and having children." "My children are young and I enjoy making a home for them." and "Because of my family with the job of belonging, being needed and helping to mold."

Responses under "Self-actualization" are responses that show awareness of growth, maturity, self-realization, and release of potential. Three women in the 35-to-45 age range selected "20 to 35" as happiest for the following reasons: "I was my own boss, good job, able to travel without opposition, marriage, children, etc." "I have good health and have been able to work, have a good home and raised my family happily." "Mentally and physically mature and able to enjoy life more." Two men, 25 and 26, selected "20 to 35" as happiest because "Having gained my education, I am better equipped to go ahead on my own and earn a living for myself and my family." "In this age period, I have a chance to use what I was taught from an early age such as honesty, responsibility, courage, etc." A 42-year-old man selected "35 to 45" because "There has been more progress toward growing, in an honest and intelligent manner." A 49-year-old man selected "45 to 60" as happiest because "The last 10 years have been the best because I am more satisfied with everything in general."

A study of the foregoing illustrations, when interpreted in terms of frequency of response, shows that predominant age preferences seem to be related to certain classifications. For example, the span "20 to 35" is most often selected for family affiliation, and the years "up to 20" are selected exclusively for freedom from worry and education. For other categories, age spans rated as happiest are not uniquely associated with designated categories. For example, the age span rated happiest because of security and stability is "35 to 45"; but four men chose "45 to 60" and three men chose "20 to 35." Based upon ratings made by both sexes, the "20 to 35" age span is most often selected for self-actualization, but men picked "35 to 45" more often than women.

As indicated in Table 5, the differences in reasons given by men and women for selecting their best years for self are significant at the .01 level of confidence (chi square $= 17.28$, $df = 6$); on reasons given for happiness in others the sex difference is not statistically significant (chi square $= 11.83$, $df = 6$, $p = .10$) and the differences on reactions to self and others are significant at .001 level of confidence (chi square $= 96.79$, $df = 6$, $p = .001$).

In other words, on reasons given for the selection of best years, the reactions of the 270 subjects differ most on self versus others (with both sexes combined). They differ between the sexes on reasons given for self-preference and do not differ significantly on reasons given for selection of best years for others. The foregoing is all that can be said in the light of the chi squares reported. However, analysis of the differences reported on each of the seven classifications suggests face-value differences that are substantial. The higher differences that seem worth additional study for the purpose of validating the significance of differences reported are as follows: Ratings for others are higher than ratings for self when the reason is "freedom from worry."

When the reason assigned is "family affiliation," ratings for self are higher than ratings of happy years for others. On ratings of happiness for self, the most marked differences occur when "family affiliation" is given as the reason for the ratings. In the category, "self-actualization," ratings by men are higher than ratings by women. In the category, "personal experience," ratings by women are higher than ratings by men. In the category, "freedom from worry," women give higher ratings than men. In "education," men give higher ratings than women when rating happiness for others. Such difference is due to the fact that a good many men (and no women) rate the age span, "20 to 35" as happiest for others. They thought that others could do what they could not do; namely, get an education in their younger years and get happier years out of them than they did. In general, men rated higher than women within the categories, "self-actualization, security and stability, hope for fulfillment and education." Women gave higher ratings than men, particularly for self, within the categories of family affiliation, personal experience, and freedom from worry.

E. Summary

The purpose of this study was to contribute knowledge to the social psychology of aging in industry. To do this, the author investigated the attitudes of workers toward five age spans of life. The author wished to determine whether attitude toward others or attitude toward self was the more reliable index of stereotypy, and to determine sex differences, if any, in stereotypy. The subjects were 270 workers from three plants under one management—180 men and 90 women; also studied were the reasons for selection of specific age spans as happiest for themselves as well as for others. The conclusions may be summarized as follows:

1. The perception of the selection of happy years of life for self and others is different. Whereas "20 to 35" is rated happiest for self, "up to 20" is rated as happiest for others.

2. The perception of years of happiness for others is more consistent and a more reliable index of stereotypy than perception of happiest years for self.

3. In perception of happiest years for self, women tend to give less stereotyped responses than men.

4. Though "20 to 35," in general, is the age period considered happiest for self, two age groups express different responses. The "up to 20" group give ratings of happiness that decline systematically with age span rated. The "35 to 45" age group follows the general pattern, but rates "20 to 35" as the happiest span of years, "35 to 45" as the second happiest span of years, and

"up to 20" as the third happiest span of years. However, the difference between mean rank of the ratings for "35 to 45" and "up to 20" is small.

5. Though there are no sex differences in stereotypy as far as mean ranks of happiness for the various age spans are concerned, there is a sex difference among people who chose the same years as happiest for self and others. The largest difference is in women who express a preference for younger years more often than men.

6. In reasons given for selection of specified age spans as happiest, the outstanding sex differences are as follows: (*a*) in preferred years for self, women are more influenced by family affiliation and personal experience whereas men are more influenced by self-actualization motives; (*b*) for expressed preferences of happy years for others, women mention freedom from worry more often than men; whereas men mention education more often than women; (*c*) in the total population, freedom from worry is more often mentioned for others than for self as a reason for selection. On the other hand, family affiliation is more often mentioned for self than for others. Differences reported in Table 5 would be worth investigating on a larger sample by the use of the present method supplemented by the use of a quantifiable interviewing approach.

In general terms, findings are in accord with the six hypotheses expressed in the plan for the study. The specific differences that deviate from the hypotheses are described in the relevant portions of the study. Additional studies needed are studies of age preferences of people from different backgrounds. Such studies will help determine attitudes toward age and aging.

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RUBRICS OF COMPETITIVE BEHAVIOR*[1]

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A. INTRODUCTION

In many competitive situations, opponents gain an advantage if they can categorize correctly the style of competition that will be used by the opposition and if they can modify their own actions on the basis of such estimates. In some situations, favorable outcomes can be achieved through deceiving opponents as to one's own probable use of power or by varying behavior to such an extent that the opposition cannot determine one's preferred competitive style. Since competitives situations often occur in American society, categorizations of the ways in which others compete are not inconsequential factors in interpersonal interaction. This paper shows that 8- to 12-year-old children can make such categorizations and it outlines an approach to the subject of competitive styles based on the study of games.

In this study, the third in a series of reports that deal with cultural models, games are divided into three major classes: physical skill, strategy, and chance. As used in earlier analyses (15, 16), such division classifies games by competitive style.

In games of chance (e.g., coin-matching), competitors need to trust only to luck or to the gods. In games of physical skill (e.g., bowling), competitors must use various motor skills successfully. In games of strategy (e.g., chess), competitors must make wise choices among possibilities. In the subtypes, such as games of physical skill and strategy (e.g., football), and games of strategy and chance (e.g., poker), combinations of types of competition occur.

The two preceding cross-cultural studies have shown that significant relationships can be established between child-training techniques, the three types of games mentioned above, and cultural forms (15, 16). For example, games of chance are associated with high-routine responsibility-training (doing

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chores, etc.) and a belief in the benevolence of the gods. Furthermore, persons who have routine responsibility-training and little opportunity to express initiative in other ways, *viz.*, members of the lower occupational groups, as compared with the higher occupational groups, and women as compared with men, show significantly greater preference for games of chance.

Again, it has been demonstrated cross-culturally that games of physical skill are related to higher child training in achievement and that, within this culture, those who have such higher training in achievement—the upper as compared with the lower occupational groups, and men as compared with women—play significantly more games of physical skill.

Finally, cross-cultural studies have demonstrated significant relationships between severe primary socialization, psychological discipline, high obedience training, complex societies, and games of strategy. Within this culture those who have such a child-training pattern, the higher occupational groups as compared with the lower, and women as compared with men, show a significantly greater preference for games of strategy.

The findings just discussed have been interpreted to mean that the function of games in human development is to provide a bridge between child-training pressures and adult cultural forms. It has been argued that games manage the conflicts induced by child-training pressures, by providing a buffered experience of fortune (chance), achievement (physical skill), and leadership (strategy). At the same time, by providing children with confidence in competition, games rehearse children in the cognitive attitudes towards competition that will be useful ultimately in maintaining related adult cultural forms. Games of chance rehearse hope for success by luck. Games of physical skill rehearse hope for success by the exercise of speed and power. Games of strategy rehearse hope for success by wise or clever decision making. All types of games assuage anxieties about competition by a reduction of the scale on which competition occurs. At the same time, games rehearse the very process of competition itself.

Such an interpretation of games (see 16) provides the basic assumptions that underly the present paper: namely, that some of the major concepts that children have about competition are drawn from their experiences with games; that games are model forms of real competition; and that the model function of games occurs because games, as well as the styles of competition of which they serve as models, are expressions of cognitive attitudes towards competition that arise out of the characteristic interaction of child-training processes and cultural prescriptions briefly outlined above.

The major purpose of this paper—more limited than the preceding statement of assumptions might imply—is to serve as a first step towards confirming the assumption that games constitute models of real competitive styles. The authors' intent is to find out whether concepts of competition similar to those involved in games can be used by children to categorize each other competitively. The question will be whether or not children can categorize each other as persons who act (*a*) like players in games of chance and try to succeed by relying on luck, i.e., are *fortunists;* (*b*) like players in games of physical skill who try to succeed by applying physical power, i.e., are *potents;* or (*c*) like players in games of strategy who try to succeed by making wise decisions, i.e., are *strategists.*

To show that children can use conceptual categories which the investigators have derived from games will not, of course, prove that children derive their own understanding of these categories from playing games, though it will contribute support for that position. To show that children, reliably, can place each other in the categories just outlined will not contribute information about how adults or children actually compete. Such demonstration will indicate only that children can classify each other in the terms specified. Even if, in nongame behavior, individuals compete in the three ways specified (and this investigation says nothing about this), it is probable that any given individual's competitive style is too complex to be comprehended completely by a game triad and its combinations. It should be noted that, even in game behavior, terms sometimes are confounded. Thus, when playing a game of a given type, some players use a competitive style that has been borrowed from some other type of game. For example, a poker player may make such strong use of his resources that his style is more like that of a physical-skill player than like that of the usual poker player.

In sum, the demonstration that children can categorize each other in terms derived from games cannot demonstrate that the categories used are learned by playing games; further, it does not mean that the categorization tells how any individual will behave in or out of games. What such demonstration does do is (*a*) to make the positions stated more probable, and (*b*) to indicate indirectly the value of the general thesis that games are models of forms of behavior to be found in everyday life. Thus, it seems possible that if children can categorize each other in terms of game strategy, their estimates may parallel nongame behavior. Research on leadership in childhood, for example, has involved the observation of behaviors that seem to be related to some of the game types mentioned. Merei (9) talks of "order-givers" (potents) and "diplomats" (strategists). Parten (13) mentions "brute-force" leaders (potents) and "artful-directors" (strategists).

B. SUBJECTS AND PROCEDURE

Children between the ages of 8 and 12 years were selected for study, as unpublished research of the authors suggests that it is from the ages of 8 to 12 when competitive games have the greatest rehearsal value. After preliminary conversations with groups of children, it was decided that the characteristic determination of game-type competitive styles could be identified by means of a guess-who type sociometric technique. The questions chosen are printed below.

The first four questions are relevant to social success, the second four are relevant to success in facing obstacles. The questions were intended to aid in the selection of children viewed as favoring the following styles: strategic styles (strategists), questions 1 and 7; power styles (potents), questions 2 and 6; luck styles (fortunists), questions 3 and 5; and noneffective competitive styles (failures), questions 4 and 8. The questions were submitted to 253 children in Grades 3 through 6 at Kenwood School, Bowling Green, Ohio. Bowling Green is a rural university town of about 12,000 persons. It has five elementary schools. There are no marked differences between schools, but Kenwood has the highest occupational ratings.[2]

The form that the children were asked to complete was as follows:

> On this page (i.e., page 1), there are a number of ways of being successful with other people. Pick out the persons in your class that seem to fit each of these types. Put the same person under only one of the types on this page. Only write down names when you feel fairly sure that that is what the person is like. Write down as many or as few as you wish. Read over all the types on this page before entering any names.
>
> 1. Who gets the others to follow them because they have lots of good ideas for things to do?
>
> 2. Who gets the others to follow because they are strong or fast or powerful?
>
> 3. Who gets the others to follow because they tell of the marvelous or magical things that will happen?
>
> 4. Who are never able to get anyone to follow them whatever they do?
>
> On this page (i.e., page II), there are a number of ways of being successful in overcoming difficulties such as getting chores done, passing

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[2] Thanks are due to the principal, Harlan Lehtooma, and the sixth-grade teacher, Mr. Robert Beard, for help with the original formulations. Other teachers who provided assistance in the administration of the tests were Mrs. E. Currie, Mrs. Ruth Eisenhour, Mrs. Kathryn Shanks, Mrs. Georgia Cross, Mrs. Virginia Draney, Mrs. Betty Crawford, Mrs. Jane Brodt, Mrs. Donelda Adams, Miss Doris Mawer, Mrs. Laura Benham, Mrs. Margaret Shaddix, and Mrs. Betty Laukhauf.

> exams, constructing or making things. Pick out the persons in your class that seem to fit each of these types. Put the same person under only one of the types on this page. Only write down names when you feel fairly sure that that is what the person is like. Write down as many or as few names as you wish. Read over all the types on this page before entering any names.
>
> 5. Who gets over difficulties by seeking for good luck or guessing?
> 6. Who gets over difficulties by being strong, or fast, or by doing very hard work?
> 7. Who gets over difficulties by thinking things out carefully beforehand and by having clever ideas?
> 8. Who gives up and does not try to get over difficulties?

There were two classes of children at each grade level. The children are chosen for these classes in an effort to ensure comparability of achievement, intelligence, and sex distribution. It the analysis that follows, the boys' and girls' scores for the two separate classes at each grade level are transformed into percentages and are combined for the two sexes separately. Such procedure rests on the assumption that the two separate social fields at each grade level can be regarded as equivalent for the purposes of our investigation. Despite the fact that the assumption is not without precedent (21), a procedure based on it contributes unspecified variation to our results (6).

As is usual with the type of sociometric instrument used in this study, the frequency of attributions on the items of the scale were skewed. A few children received most of the "mentions." Some children received none. In general, levels of response were higher for strategy and power than they were for fortune and failure. Except at the 4th-grade level on item 2 (social power), on which boys received significantly more mentions than girls ($p < .05$), the sexes did not differ significantly in the numbers of attributions received. However, there was a directional tendency for boys to receive more attributions on power questions 2 and 6 and on luck (question 5).

As the authors intended to combine the two separate aspects of each variable (the social aspect and the obstacle aspect), they computed rank-difference correlations between the appropriate pairs. All correlations between the strategy items (1 and 7) in Grades 3, 4, 5, and 6 were significant for both boys and girls ($p < .05$). Correlations varied between .37 and .85 and had a mean value of .68. With one exception, correlations between the power items (2 and 6) were significant ($p < .05$). They varied between .34 and .69 and had a mean value of .51. For the chance items, only two correlations out of eight were significant. They ranged from —.34 to +.36 and had a mean value of .08. All correlations for the failure items (4 and 8) were significant ($p < .01$). The values varied between .56 and .78 and had a mean value of .65. Clearly there was justification for combining the two aspects of strategy, power, and failure, but not for combining the two aspects of chance. Therefore, so far as strategy, power, and failure are concerned, children show some consistency in categorizing each other.

As scores on strategy, power, failure, and chance were to be used for further analysis, it was necessary to investigate the extent to which the measures were interrelated. For such purpose, the attributions were summed for pairs 1 and 7, 2 and 6, and 4 and 8; but the chance items that did not correlate with each other were treated separately. The rank-difference correlations among various combinations are presented in Tables 1 and 2.

Tables 1 and 2 show that the strategy and power variables overlap considerably and appreciably more for girls than for boys. Similarly, failure (items 4 and 8) and luck (number 5) are closely associated throughout all grades, though appreciably more so for boys than for girls. Failure is significantly related to magic (number 3) only in the third grade. In contrast, strategy (items 1 and 7) is negatively related to luck (item 5) in most grades. Because the luck item (number 5) evoked a higher level of response than the magic item (number 3), and had more clear-cut relations with other items, it was chosen to represent the chance category. The magic item (number 3) was discarded from further analysis.

In explanataion of the relationships between luck and failure, results of previous research imply that luck and failure are intrinsically connected insofar as persons in positions of socioeconomic inferiority prefer games of chance to other types of games. In the present instance, however, all that can safely be concluded is the presence of a negative halo effect that prevents discrimination between luck and failure.

Previous research with sociometric techniques as devices for selecting children who are leaders has demonstrated that children to whom prestige is attributed have a greater influence upon their peers than do children to whom prestige is not attributed (14). An estimate of the validity of the instrument devised by the authors to measure competitive success was determined by comparing results secured with it to teachers' ratings of the children. Teachers in the eight classes were asked to indicate those children who were successful and those who were failures, in the classroom and on the playground. Teachers were asked to name only as many children as they could classify accurately.

Seventy-six per cent of the boys and girls named by the teacher as successful in the classroom were found to be in the top quarter of the distribution of attributions received as strategists. Fifty per cent of the children named by the

TABLE 1

RANK-DIFFERENCE INTERCORRELATIONS BETWEEN STRATEGY, POWER, MAGIC, AND LUCK (BOYS)

Game type	Third grade ($N = 38$)				Fourth grade ($N = 23$)				Fifth grade ($N = 48$)				Sixth grade ($N = 30$)			
	(1 & 7)	(2 & 6)	(4 & 8)	(3)	(1 & 7)	(2 & 6)	(4 & 8)	(3)	(1 & 7)	(2 & 6)	(4 & 8)	(3)	(1 & 7)	(2 & 6)	(4 & 8)	(3)
Strategy (1 & 7)																
Power (2 & 6)	.48**				—.14				.67**				.27			
Failure (4 & 8)	—.28	—.28			—.64**	—.03			—.67**	—.02			—.58**	—.51*		
Magic (3)	.14	.02	.48**		—.13	.04	.21		—.17	—.13	.14		.32	.19	—.03	
Luck (5)	—.03	—.18	.06	.36**	—.69**	.25	.71**	.11	—.38*	—.34*	.75**	.04	—.42*	—.22	.51**	—.34

* $p < .05$.

** $p < .01$.

TABLE 2
RANK-DIFFERENCE INTERCORRELATIONS BETWEEN STRATEGY, POWER, MAGIC, AND LUCK (GIRLS)

Game type	Third grade (N = 27)				Fourth grade (N = 36)				Fifth grade (N = 21)				Sixth grade (N = 30)			
	(1 & 7)	(2 & 6)	(4 & 8)	(3)	(1 & 7)	(2 & 6)	(4 & 8)	(3)	(1 & 7)	(2 & 6)	(4 & 8)	(3)	(1 & 7)	(2 & 6)	(4 & 8)	(3)
Strategy (1 & 7)																
Power (2 & 6)	.48**				.80**				.72**				.44*			
Failure (4 & 8)	—.60**	—.52**			—.55**	—.49**			—.78**	—.73**			—.71**	—.46*		
Magic (3)	.05	—.10	.47*		.13	.19	.26		.41	.34	.11		.33	.12	—.18	
Luck (5)	—.06	—.03	.13	.35	—.13	—.16	.37*	.08	.18	.03	.11	.22	—.32	.09	.51**	.16

* $p < .05$.
** $p < .01$.

teachers as successful in the playground were in the top quarter of the distribution of attributions received as potents. Only four potents as compared with 59 strategists were classified by the teachers as classroom successes, but 17 strategists as against 34 potents were classified by the teacher as playground successes.

It seems not unnatural that teachers' judgments should be closer to those of children for classroom success than for playground success. When all teacher-mentioned successes are combined and are compared with the top quarters of the distributions on strategy and potency, there is found an 83 per cent overlap. Such consistencies between the ratings made by teachers and those made by children indicate, by and large, that the children in the top quarters of the strategy and potency distributions are the successful children in school. Whether such children are successful because they are strategists or because they are potents, or are successful simply because they are smart in the classroom and good at sports, has not been established. If the third alternative is in fact the case, the children simply have equated the categories of this investigation to the more traditional rubrics: "brains" and "brawn."

Sixty-five per cent of the boys and girls mentioned by the teachers as failures in school or as failures on the playground were in the top quarters of the sociometric measures for luck and failure.

All together, the results just discussed indicate considerable agreement between teachers and children in selecting children who are successful, but less agreement in selecting those who are failures.

If our study were to stop at this point, we would have established the point that children can categorize each other in terms of these conceptional labels; but we would not have proved the hypothesis that children responded in the terms intended by the investigators. Further evidence is needed to support the view that the labels used by the investigators correspond to real concepts of competition in the lives of children. To this end, the children who scored in the top quarters of the distributions in each of the categories were selected for further study. Because of the interrelations among some of the variables, it was necessary to deal with groups of children who were in the top quarters of the distributions on more than one category of rating. Table 3 indicates the number of boys and girls in each grade who were in the top quarters, or top portions, of specified distributions. Each grouping in Table 3 was given a name so that it could be distinguished from game types to be referred to later.

Sex differences are apparent in each of the categories in Table 3. Thus, while there are approximately equal numbers in the potent-strategist category (PS) for the two sexes, there are slightly more girls than boys in the strategist

TABLE 3
NUMBER OF CHILDREN APPEARING IN THE UPPER QUARTERS ON THE COMPETITIVE-STYLE SOCIOMETRIC

Grade levels	Girls							Boys						
	PS*	S	P	PC	C	CF	F	PS	S	P	PC	C	CF	F
6	8	5	0	2	1	3	5	4	6	1	2	1	5	1
5	4	4	2	1	3	0	0	8	1	4	3	0	8	1
4	4	5	1	0	2	4	3	4	4	1	4	0	2	0
3	5	4	0	1	1	2	3	6	3	5	1	2	5	3
Totals	21	18	3	4	7	9	11	22	14	11	10	3	20	5
Combined totals			7		16					21		23		

* PS = Potent-Strategists (power and strategy), S = Strategists (strategy), P = Potents (power), CF = Fortunist-Failures (chance and failure), PC = Potent-Fortunists (power and chance), C = Potents (chance), and F = Failures (failure).

(S) category. In contrast, there are more boys than girls in the various potent (P) categories. There are more boys than girls in the power category (potents) and more boys than girls in the combination category of power and luck (PC). For the girls, there are approximately equal numbers in the luck category (fortunists), the combination luck and failure (fortunist-failures), and the failure category (failures). The majority of boys mentioned on luck, luck and failure, and failure, are in the combined category of luck and failure. Though it is likely that sex differences are produced by the relative importance of game strategies in the behavior of boys and girls, it is possible that characteristics of the classes of students used (e.g., the balance of boys and girls; differences across age levels) could be responsible for some of the variability demonstrated. Nevertheless, the generalization that girls discriminate failure more finely than boys, and that boys discriminate success better than girls, is supported by previous cross-cultural research reported by the authors (16).

After the children had been selected to represent the success styles given in Table 3, they were classified (*a*) on the basis of their fathers' occupations and (*b*) on group intelligence-test scores. Scores on the California Test of Mental Maturity were available for children in the sixth grade and on the Science Research Associates Intelligence Test for children in the third, fourth, and fifth grades. Both tests had been administered within the two years preceding our study.

All other assessment data, it should be noted, were secured between April and May of 1961; i.e., at the end of the school year when class members had considerable familiarity with each other.

A short form of the Tuddenham reputation test was administered to the children (22). This test contains 12 pairs of contrasting characteristics. On it children are asked to name those who best typify the characteristics mentioned. The contrasting pairs are as follows: wiggly or quiet, popular or not having many friends, full of fun or serious, quarrelsome or not quarrelsome, taking chances or not taking chances, bossy or not bossy, a poor sport or a good sport, bashful or not bashful, good at games or not good at games, getting mad easily or doesn't get mad, a sissy or a real boy (for boys), a tomboy or acts like a lady (for girls), and who would he or she select as a best friend?

From responses to the Tuddenham test, a maladjustment index can be derived. For each child, this index is the ratio of favorable to unfavorable mentions. Evidence for the validity of such an index is supplied by a research program of one of the authors.[3] Without demonstration of validity, there might be circularity in the use of sociometric data to gain insight into competitive styles when these styles are determined by use of a sociometric device.

Finally, a forced-choice game-scale was administered. Previous research had established the responses of several thousand children to a list of 180 games and pastimes (21). Upon the basis of the responses secured in this earlier study, items were selected to which at least 50 per cent of the children had responded with recognition and preference. Items selected represented each of four major classes: physical skill (P); physical skill and strategy (PS); strategy (S); and strategy and chance (SC). Items for boys were not the same as for girls.

The biggest difficulty was found in selecting "chance" items. Pure chance items could not be found because there were few of them on the original list (which had been constructed to be representative of childrens' games). Furthermore, with the exception of Bingo, "chance" items did not evoke a 50 per cent level of response.

Each set of items was paired with each other set of items, and the position of each item was rotated to eliminate position effects.

C. HYPOTHESES

1. As previous research treated power and strategy separately, there was no background for making hypotheses about children who were outstanding in both respects. Nevertheless, the authors surmised that potent-strategists should be more successful in all attributes tested.

2. Previous research on the child-rearing antecedents of strategy players

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[3] This latter research program involves the administration of the sociometric index, the Bender-Gestalt test, and other indices of maladjustment to hundreds of children in Grades 3 to 6. The project is under the direction of Elmer Morgan, Jr., Psychology Department, Clark University, Worcester, Massachusetts, and was reported at the meetings of the Midwestern Psychological Association in Chicago, May, 1962.

indicated that such players experienced much severity in childhood, but that they also experienced a psychologically-oriented discipline that led to a readiness to displace aggression into symbolic forms (16). It was predicted, therefore, that strategists (*a*) would be considered less aggressive; (*b*) would show greater preference for strategy games than would other groups; (*c*) would reveal more interest in physical skill games (e.g., bowling) than in games of physical skill and strategy (e.g., boxing); and (*d*) would be of higher socioeconomic classification and intelligence than would potents and fortunists.

3. It was predicted that potents (*a*) would be considered more forceful; (*b*) would show greater preference than would strategists or fortunists for outdoor games of physical skill; (*c*) would be better at outdoor games of skill than would strategists and fortunists; and (*d*) would rank lower in intelligence than strategists.

4. Previous studies of games of chance have linked games, cross-culturally, to the routine pursuit of economic responsibilities and to other behaviors that do not require the exercise of initiative (16). It was predicted, therefore, that in a success-oriented society, fortunists, i.e., children named as relying on chance (*a*) would be less successful on all sociometric characteristics; (*b*) would be less intelligent; and (*c*) would be of lower socioeconomic status.

Because of our inability to use pure chance items in the game inventory, no predictions could be made with regard to game choice. Earlier cross-cultural studies have indicated that when chance and strategy games are combined, the pattern of relationships is more like those found with games of strategy than like those found with games of chance.

As previous studies have indicated that competitive games are important in the sex-role development of boys from the third to sixth grades, but have a lesser importance for the sex-role development of girls, it was predicted that game-choice hypotheses would be more likely to hold true for boys than for girls (21).

D. RESULTS

1. *Socioeconomic Status*

Potent-strategists, and strategists (both boys and girls), are significantly higher in socioeconomic status than are fortunists and failures. Chi squares vary between 8.19 (when female strategists are compared with female failures) to 17.76 (when male strategists are compared with male fortunist-failures). All chi squares are significant beyond the .01 level.

The socioeconomic status of potents does not differ significantly from that of any other group.

2. *Intelligence*

Table 4 shows intelligence quotients to be in the predicted directions. Strategists and potent-strategists have significantly higher *IQ*s than do children in other groups. All *t* values are significant beyond the .05 level.

TABLE 4
INTELLIGENCE QUOTIENTS OF BOYS AND GIRLS OF THE VARIOUS COMPETITIVE STYLES

Competitive style	*N*	Boys Mean	*SD*	*N*	Girls Mean	*SD*
Potent Strategists (PS)	20	120.65	11.02	19	119.16	8.69
Strategists (S)	11	124.27	14.29	14	125.14	10.93
Potents (P)	15	100.80	10.44	5	102.80	11.30
Fortunists-Failures (CF)	19	103.42	8.02	13	108.67	9.38
Failures (F)	5	110.80	3.10	12	104.58	16.98

3. *Sociometric Measures*

On the paired sociometric characteristics, the various groups were compared in terms of a nonparametric median test. See Tables 5 and 6. The potent-strategist groups of boys and girls are superior to the fortunist-failure group on nearly all characteristics. Strategists and potent groups are also superior to fortune and failure groups on most characteristics.

Potent-strategists and strategists are like each other in that both receive higher attributions (*a*) on being quieter, (*b*) on not getting mad, and (*c*) on being better sports than potents and fortunist-failures.

Potent-strategists are more like potents than they are like strategists or fortunist-failures on items that involve (*a*) taking chances, (*b*) being more bossy, and (*c*) being good at outdoor games. When the strategy group is contrasted with the potent group, we find the strategy group (*a*) to be quieter, (*b*) to take fewer chances, (*c*) to be less bossy, (*d*) to be less proficient in sports—but good sports, and (*e*) to be less easily riled than potents. The foregoing picture is consistent with the notion that strategists are less inclined to use physical force and are less adequate at physical-skill games, but are perhaps more subtle in social relations. In contrast to strategists, potent boys (*a*) are more wiggly, (*b*) take more chances, (*c*) are more bossy, (*d*) are better at sports, and (*e*) get mad more easily. Such tendencies are consistent with the idea that potents have a physically forceful approach to success.

When the female groups are compared, we find that the girls most often mentioned as successes are the girls most often mentioned in a desirable sense on the Tuddenham test. Potent-strategist girls and, to a lesser extent, strategist girls are said to have all the favorable characteristics; and the fortunist, fortunist-failure, and failure groups are said to have the undesirable charac-

TABLE 5

SOCIOMETRIC CHARACTERISTICS OF COMPETITIVE STYLES (BOYS)

Positive sociometric characteristics	Positive scoring groups	Negative scoring groups PS ($N = 22$)	S ($N = 14$)	P ($N = 9$)	PC ($N = 11$)	PPC ($N = 20$)	CF* ($N = 23$)	Negative sociometric characteristics
more quiet	PS				$< .001$	$< .01$	$< .001$	wiggly
	S				$< .05$		$< .05$	
popular	PS		$< .01$	$< .02$	$< .05$	$< .001$	$< .001$	nobody likes
	S						$< .001$	
	PPC						$< .001$	
more fun	PS					$< .01$	$< .001$	don't smile, sad
	S						$< .01$	
	PPC						$< .02$	
less quarrelsome	PS						$< .05$	gets into arguments
takes chances (bravest)	PS		$< .001$				$< .001$	doesn't take chances
	PPC		$< .05$				$< .001$	
more bossy	PS		$< .02$				$< .02$	not bossy
	PPC		$< .05$					
good sport	PS				$< .01$		$< .01$	poor sport
	S				$< .10$		$< .05$	
	PPC						$< .10$	
not bashful	PS						$< .001$	most bashful
	S						$< .001$	
	PPC						$< .001$	
good at games (outdoor)	PS		$< .01$				$< .001$	not good at games
	S						$< .10$	
	PPC		$< .05$				$< .001$	
doesn't get mad	PS					$< .10$	$< .05$	gets mad easily
	S					$< .02$	$< .02$	
has more friends	PS						$< .001$	has few friends
a real boy	PS						$< .001$	a sissy
	S						$< .001$	
	PPC						$< .001$	
Adjustment Index	PS		$< .001$			$< .001$	$< .001$	
	S						$< .001$	
	PPC						$< .01$	

* Absence of protocol made it impossible to compare the small F group ($N = 5$) on these characteristics.

TABLE 6

SOCIOMETRIC CHARACTERISTICS OF COMPETITIVE STYLES (GIRLS)

Positive sociometric characteristics	Positive scoring groups	Negative scoring groups PS (N = 21)	S (N = 18)	P (N = 7)	CF (N = 15)	F (N = 12)	Negative sociometric characteristics
more quiet	PS				< .005		wiggly
	S				< .005		
popular	PS		< .05	< .004	< .002	< .002	nobody likes
	S			< .03	< .004	< .001	
	P				< .03	< .01	
more fun	PS		< .01	< .002	< .002	< .002	don't smile, sad
	S				< .02	< .004	
	P				< .05	< .01	
less quarrelsome	PS		< .01		< .004	< .002	gets into arguments
	S					< .02	
takes chances (bravest)	PS				< .003	< .002	doesn't take chances
	S				< .05	< .009	
more bossy	PS					< .005	not bossy
	S					< .004	
	P					< .05	
good sport	PS			< .004	< .004	< .005	poor sport
	S				< .01	< .01	
not bashful	PS			< .05	< .004	< .005	most bashful
	S				< .003	< .002	
good at games (outdoor)	PS		< .05	< .04	< .002	< .005	not good at games
	S				< .004	< .002	
doesn't get mad	PS				< .004	< .005	gets mad easily
has more friends	PS				< .004	< .005	has few friends
	S				< .004	< .02	
	P				< .02	< .03	
acts like a lady			ns	ns	ns	ns	tomboy
Maladjustment index	PS				< .005	< .002	
	S				< .005	< .005	
	P				< .05	< .01	

teristics. The contrasts between potent-strategist girls and failure girls are marked.

Strategists are distinguished from potents only by being more popular. Fortune-failure girls are distinguished from failure girls in that they are said to be more wiggly, and more bossy. Interestingly, there are no differences on femininity between the foregoing groups of girls. Our results reveal a distribution of ratings in which potent-strategists and strategist girls have widely dispersed scores as ladylike or as tomboys, but fortunist and failure girls received less variable ratings. This relative lack of variability implies less definite sex-role characteristics. The scores reflect the fact that girls from 8 to 12 appear to be uncertain about the most desirable sex-role characteristics (11). To be a well-adjusted boy is to be a real boy. To be a well-adjusted girl need not have the implication that she be ladylike. In general, our sociometric findings for girls indicate a less differentiated concern for types of competitive success than is the case for boys.

4. *Games*

Tables 7 and 8 give the average scores and standard deviations for the total class groups and the success-style groups on the forced-choice game-inventory. A major prediction that, on strategy games, strategy groups would have higher scores than the potent group is confirmed for boys ($t = 2.64$; $p < .05$). For boys, strategists also have significantly higher scores on strategy games than do

TABLE 7
SCORES ON FORCED-CHOICE GAME-INVENTORY (BOYS)

		Games							
		PS Games baseball football wrestling boxing basketball		P games darts tug o' war footraces bowling horseshoes		S games tic-tac-toe dominoes checkers scrabble I've got a secret		SC games bingo cards 7-up rummy monopoly	
Success types or grade group	*N*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Potent-Strategists	22	63.18	10.15	43.23	7.68	17.73	8.55	24.27	12.48
Potents	21	60.33	12.15	43.71	9.23	17.48	9.49	21.43	10.62
Strategists	14	51.14	17.50	45.39	10.18	27.36	11.25	27.28	9.54
Fortunist-Failures	22	53.77	14.95	38.94	11.63	23.64	8.93	25.73	13.47
Grade 3	32	54.31	11.94	41.72	12.79	22.06	8.99	26.75	10.14
Grade 4	22	53.86	17.16	47.32	8.59	23.91	10.16	24.23	13.28
Grade 5	43	56.14	13.21	44.23	9.86	21.09	9.69	27.05	11.85
Grade 6	28	63.96	10.64	39.54	8.41	19.18	10.58	26.00	11.17

TABLE 8
SCORES ON FORCED-CHOICE GAME-INVENTORY (GIRLS)

Success type or grade group	*N*	Games							
		PS games baseball basketball volleyball dodgeball ping pong		P games jacks hopscotch jump rope tug o' war leapfrog		S games tic-tac-toe dominoes checkers scrabble I've got a secret		SC games bingo cards 7-up rummy monopoly	
		Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Potent-Strategists	16	55.44	19.42	25.25	13.10	30.00	12.15	39.98	10.75
Potents	5	50.20	6.18	39.60	14.44	32.40	8.69	26.60	5.20
Strategists	18	58.28	13.29	32.94	10.26	23.83	8.94	31.78	8.08
Fortunist-Failures	15	50.12	18.46	33.76	13.18	21.88	12.23	39.47	15.57
Failures	11	41.73	18.21	41.91	12.51	41.91	12.47	41.09	7.99
Grade 3	25	45.24	17.92	38.84	11.82	25.80	11.29	37.20	12.34
Grade 4	33	48.97	19.35	40.24	14.73	24.58	11.08	30.30	12.50
Grade 5	14	59.64	12.07	26.64	12.27	26.71	11.28	34.43	14.22
Grade 6	24	58.50	12.49	26.83	13.57	22.04	9.20	39.04	8.77

members of the potent-strategy group ($t = 2.64$; $p < .05$). Strategists do not, however, have higher scores than the fortune-failure group ($t = 1.01$).

A prediction that potent boys would have higher physical skill and strategy and higher physical-skill game-scores than the strategy group was not entirely confirmed. There were no significant differences in scores between any of the groups on the games of pure physical skill (P). On physical-skill and strategy games (PS) which, it will be remembered, include the exercise of physical force, as physical-skill games do not, there are important differences. The mean score for potent boys is higher than the mean score for strategists. The difference, however, is not significant ($t = 1.65$).

The potent-strategist boys have significantly higher scores on physical-skill and strategy games than do either the strategy group or fortune-failure group ($t = 2.39$, $p < .05$; $t = 2.26$, $p < .05$).

The physical-skill and strategy games are the only games on our inventory for which there is a significant increase in preferences between the third and sixth grades ($t = 3.26$, $p < .01$); thus the potent-strategist boys' choice of games is an indication of greater game maturity. On the other hand, the strategy boys' game choices are very similar to those of the fortune-failure group. Strategy boys as well as fortune-failure boys show a lower preference for forceful physical-skill and strategy games which, as the means scores indicate, are the most popular boys' games from the age of 8 to the age of 12.

There is consistency between the fortune-failure boys' unpopular game choices and their unpopular sociometric characteristics. On the other hand, the strategy boys, with their unpopular game choices, and with their relatively popular sociometric characteristics are much more paradoxical. While not wholeheartedly in pursuit of the games typical for boys of the age level under consideration, strategy boys (in some way) have managed to remain fairly acceptable to their classmates. In this respect, at least, the strategy group is deceptive.

The girls' responses on the game inventory do not make much sense in terms of the above prediction. For this lack of sense, there are several possible reasons. First, the girls' form of the forced-choice scale shows less constancy over grade levels than does the boys' form. (The physical-skill and strategy and the physical-skill items' content differed between boys' and girls' inventories; but the strategy and the strategy and chance items were the same.)

There is a significant decrease between Grade 3 and Grade 6 in girls' preferences for physical-skill games ($t = 3.23$; $p < .01$) and a significant increase in girls' preferences for physical-skill and strategy games ($t = 2.95$; $p < .01$). The significantly higher preference of the strategist girls over the failure girls for physical-skill and strategy games ($t = 2.51$; $p < .05$), may indicate greater maturity for the strategists. In reverse, the higher preferences of failure girls for physical-skill games ($t = 3.20$, $p = < .01$) may indicate greater immaturity.

The second possible reason for lack of sense in the results for girls is that girls' responses to play inventories do not have the same sex-role significance after the age of 9 years, as do those of boys (21). Girls' choices are more dispersive and are more varied in significance, although there is a tendency for them to show an increasing preference for masculine items throughout the age period studied. It is noticeable that the strategy girls' scores for the strategy, and strategy- and chance-game categories more nearly approach the total boy averages than do those of any other girl group. The failure girls, in having significantly higher scores than the strategy girls on the games of strategy ($t = 4.02$; $p < .01$), and on strategy and chance games ($t = 2.91$; $p < .01$), are the most feminine; and are the least consistent with the age trend towards increasing preference for masculine items. While we can say that strategy girls show strategy in indicating the games that have the greatest maturity and greatest sex-role value at the age levels studied (they are ahead of potent-strategists in this respect), this means that they do not use the inventory games in the same ways that boys do.

In the case of boys, it is clear that boys classified as strategists or potents do differ in their game preferences in line with predictions. This difference would seem to indicate that boys' ability to estimate each other consistently is based on corresponding real life behaviors.

E. Discussion

It has been demonstrated that when children are asked to categorize each other on a sociometric device that differentiates between concepts, such as cleverness, power, luck, and failure, the children assigned to different categories differ from each other in terms of teacher's ratings, socioeconomic status, intelligence, and social character. The original terms of the sociometric ratings were derived from a study of variables that are important in determining the outcomes of the three major classes of games: games of chance, games of physical skill, and games of strategy. Outcomes in games of chance are determined by lot, outcomes in games of physical skill are determined by power, and outcomes in games of strategy are determined by rational choice.

Our results show that boys make distinctions among children who succeed by strategy, children who succeed by power, and children who succeed by using a combination of these two types. Boys do not, however, appear to distinguish clearly between children who succeed by good fortune and those who simply fail. To succeed by luck is apparently tantamount to failure.

Girls, on the other hand, distinguish between children who succeed by fortune and those who simply fail. The largest difference between the two groups is to be found in the girls' game preferences in which the fortunist-failures are not unlike the success groups in their responses, whereas the pure failure group is atypical and immature. The distinction made by girls between potent-strategists, strategists, and potent seems not to be a distinction in type as it is with boys so much as a distinction in degree. Potent-strategists have most of the desirable characteristics, strategists somewhat less, and potents even less; but all three groups are superior to fortunists and failures.

One method of assessing the value of the theoretical constructs that have been used to interpret our results is to see if the results can be comprehended in simpler terms.

Most of the girls' results can be explained in terms of halo effects. Girls who get positive mentions on the original competitive-style sociometric test get positive mentions on the social-characteristics sociometric test. The distinctions made between fortunists-failures and failures, however, do not fit this interpretation. If simple halo effects are operating, why should girls make more distinction between categories than do boys? In the light of the literature that suggests that girls' responses to failure are different from those of boys, it would seem unwise to neglect the distinction (5). It has been demonstrated, for example, that girls and younger children have a willingness to give up in the face of failure experiences; whereas older boys tend to work harder in an attempt to overcome failure.

Another explanation of the results might be in terms of occupational differences, but while such differences exist they cannot explain the differences within the most successful groups (PS *vs.* S) or within the least successful groups (CF *vs.* F), or explain the lack of distinction between any of these four groups and the potent group. Insofar as socioeconomic classes are usually associated with differences in child training, however, we would expect a more sophisticated approach to these differences to be systematically related to competitive styles.

Some of the differences between groups might be attributed to differences in intelligence. The differences between strategist and potent boys, for example, might be explained in terms of their great differences in intelligence. It makes sense that duller children should be crude socially and should prefer simpler games of physical skill to those of strategy. But, such a line of explanation is inadequate to explain the differences between potent-strategists and the strategists who do not differ on intelligence, but who are distinct socially, as well as in their game preferences. Theory must explain why the potent-strategists are good at outdoor sports and are seen as good sports; why strategists, not good at outdoor sports, are perceived as good sports; and why potents are good at outdoor sports, but are perceived as poor sports. A conceptualization more complex than that provided by simple differences in intelligence seems to be required. One implication of this paper is that differences in intelligence may sometimes be less important than the way in which intelligence is used, and that there are characteristic applications of intelligence to competition that may be as important as the sheer level of intellectual power.

A final alternative explanation of our results would be that strategy and potency can be subsumed under the rubrics of "brains" and "brawn," traditional categories for schoolroom and playground success. Once again, however, such categorization fails to account for differences within success groups and within failure groups.

As mentioned in the introduction, the authors favor the view that children can categorize each other in these various terms, not simply because the investigators provided these categories for them, or because they do in some way reflect distinctions based on popularity, intelligence, and social class; but because there are in the real world distinctive techniques of success which are both recognizable to children and used in games. It must be admitted, however, that the evidence provided by the present study is incomplete. In the remainder of this paper, therefore, further corroborative support for the formulations will be presented.

Earlier papers have implied that cognitive attitudes that involve applications of intelligence to competitive success (strategy, potency, fortunism) are developed by distinctive patterns of child training, are rehearsed in games, and subsequently are available for use by the mature individual. Each style will now be discussed in terms of its presumed development.

The earliest protogames of children are mixtures of physical skill and strategy, and physical skill and chance (such as "hide and seek," "egg in the nest"). Later forms emerge out of these protoforms (18). In terms of conceptual demands, games of chance are at the lowest level.

Perhaps, because customarily it is not thought of as a competitive style, fortunism is the most difficult of the competitive styles to understand. In Man, Play and Games, Caillois (4) argues that contemporary neglect of games of chance is a by-product of an ethnocentric attitude toward games. He says that games of chance are the characteristic competitive games of the lower socioeconomic orders. "Being conscious of their inferiority they do not trust in exact, impartial and rational comparisons. They, therefore, turn to chance, seeking a discriminative principle that is kinder to them" (4, p. 114). Lowenthal (7) has argued that in the popular biographies of the mass-circulation magazines read by the lower social orders there are also provided chance or fortunist models. Such biographies imply that success is due to lucky breaks that occur to heroes who await passively their chances. Thus, from these other studies, some cogency is given to the view that games of chance may serve as models of widespread attitudes toward competitive success as, in previous studies by these investigators, these games have been associated with the lower socioeconomic orders (19) and with nonachievement (16). In psychological terms, also, it is customary to associate a preference for extreme chance taking with an immature mental state (2) or with a nonachieving style of performance (1). It is not certain to what extent later rebuffs can force older children or adults back upon these more passive fortunistic attitudes toward success, yet it seems probable that most adults, through prayer, invocation, or personal optimism retain important if not dominant response preferences for this competitive style.

Potency appears to require a developmental level higher than that required by fortunism. It begins, perhaps, when the child is capable of the concrete categorizing operations mentioned by Piaget. From about 6 years onwards children can decide objectively whether they or their competitors can run faster, are bigger, have more stamps, or can punch harder. Cross-culturally, games of physical skill have their strongest relations with achievement training and, therefore, seem to serve as models for the process of competition by outscoring. In adult life, the marks of this potent competitive style are omnipresent.

The fortunist style is not often accepted officially, except where there are state lotteries. Usually it is imagined to be an evil or undersirable phenomenon and is often restricted by legislation. By nature, the strategist style is self-concealing. The potent style, however, is part of the accepted ideology of our times. It is said that one is a success who outscores others. He is the one who has more money, more houses, more bathrooms, or more papers to his credit. In some primitive groups, the equivalent degree of success is assigned to the man with the greatest number of cattle, or greatest number of wives. Potency, in terms of school grades, child-developmental norms, or status seeking seems to be the most important competitive response preference of most middle-class Americans.

Strategy requires the highest conceptual level in the triad under discussion. Games of strategy involve an understanding of the principles that govern players' operations and, as competitive style, strategy corresponds to the emergence of abstract thinking in early adolescence.

An outline of the way in which a strategic style might develop out of specified child-training conditions and cultural prescriptions is as follows. Various studies (10) have shown that rational discipline without use of physical punishments leads to a preference for displaced or symbolic competition rather than to competition expressed with physical force. But stategy games are not simply conceptual exercises. They are, traditionally, war games that involve the use of deceptive leadership, the capture and the killing of the enemy, and the ursurpation of his territory (12). Such games occur in complex societies in which leadership involves sophisticated social diplomacy. Paradoxical is the fact that the strongest child-training relationships in such games are not those with leadership training. They are with obedience training.

One solution to the paradox just mentioned might be formulated in terms of a status-envy concept of identification (23). Thus, when a child experiences high obedience training he should envy strongly those who are in a position to exact obedience from him: presuming, always, that those envied control the resources that he wishes; presuming, also, that he can envisage a time in the future when he will be expected to assume control of these resources of power, authority, and property. It follows that a "good" child who appears to obey, but secretly envies, command, should become an expert in deception. He does what he is told, but at the same time he imagines what he will do when it is his turn to do the telling. Such deceptiveness is the essence of the strategic attitude in a game of strategy: the appearance of harmless moves when the intent is to usurp completely the social space of one's opponent or to "kill" his men (8). From this viewpoint, the strategic style in children is a complex defensive response to child-training situations that require high obedience and filial respect. It is an attitude that can be practiced in the classic games of strategy and it is an attitude of great value in the complexities of adult life. It is the authors' expectation that such a style is preferred most strongly at the upper socioeconomic levels, and in those levels finds its typical expressions in the worlds of law, business, and politics. For some of these expectations there appears to be support in Broverman's work on cognitive styles (3).

In conclusion, the authors assert that three competitive styles emerge developmentally—given certain child-training conditions and certain cultural requirements. In complex cultures it is assumed that all individuals will have some experience with each style though, according to particular biasses in training and opportunity, there will tend to be distinctive response preferences within each style. It is realized that this presentation of competitive styles is unrefined. But it is justified on the assumption that the attributes that determine outcomes in games may also be among the salient psychological attributes of those who play them.

F. SUMMARY

This study arose out of cross-cultural research that implied that a basic triad of games of chance, physical skill, and strategy serve as models for characteristic styles of competition. It was hypothesized that if this were true, children should be able to categorize each other competitively in terms of concepts derived from such games. A sociometric device that categorized individuals as fortunists, potents, strategists, or failures, was administered to 253 children in grades three through six. With some exceptions, it was found that children could categorize each other in the terms used and that there was consistency between their use of these categories and discriminations made by teachers of successful and unsuccessful children.

In order to check whether the children's use of the categories was consistent with the theoretical constructs on which they were based, children in the upper quarters of the distributions of sociometric attributes were compared

in terms of occupational status, intelligence, social traits, and game choice. As predicted, strategists boys, when compared with potents, were of higher intelligence, were more subtle in social relations, and preferred games of strategy and physical-skill games without physical contact. Strategists were perceived as good sports, but not as proficient in outdoor sports. Potents were perceived as poor sports, but as proficient in outdoor sports. Members of combination category of potent-strategists, while undifferentiated from strategists on occupational class, and intelligence, were perceived as proficient in outdoor sports, and as good sports. All of the categories mentioned thus far were perceived as superior to the fortunist and failure categories.

Data for girls show no such distinctions within success groups, although girls do discriminate more clearly among the failure groups. This finding was interpreted in terms of the less differentiated concern of girls for types of competitive success and in terms of their more precise discrimination of failure.

It is concluded that children can make self-consistent categorizations of each other using concepts derived from games and that the results obtained cannot be explained in terms of halo effects, social class, intelligence, or folk rubrics. Furthermore, as children (particularly boys) play games analogous to their success styles, it seems reasonable to believe that the categorizations correspond to each boy's style of competitive behavior. The results are discussed in terms of a theoretical position that games as well as competitive styles reflect underlying cognitive attitudes that emerge in developmental sequence in association with specific child-training techniques.

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COMPARING PEER STATUS RATINGS OF ELEMENTARY PUPILS WITH THEIR GUIDANCE DATA AND LEARNING EFFICIENCY INDICES*

Lompoc Unified Schools, California

RUSSELL N. CASSEL AND GILBERT MARTIN

A. PURPOSE

This study consists of comparative analyses of the relations between peer-status ratings (PSR) and guidance data. The latter data include a learning-efficiency index (*LEI*).

B. GROUPS

Subjects were children in the 5th and 6th grades of one of the 11 elementary schools in the Lompoc Unified School District, Lompoc, California. In 1960-1961, the year of the study, the pupils in the 5th and 6th grades were divided about equally with respect to sex. The mean age for the fifth-grade group was 11.2. The mean age for the sixth-grade group was 12.2. Standard deviations were 0.5 years and 0.7 years, respectively. Mean *IQ*s were 103.0 and 109.0. Standard deviations of the *IQ* distributions were 8.9 and 15.0. For all pupils in the Lompoc school district in 1960-1961, the mean *IQ* was 108; i.e., about one-half of one standard deviation above the standardization norm of 100. Socioeconomically, families in the Lompoc Unified School District are high average in relation to all families in the United States.

C. DATA

1. *Peer-Status Ratings*

Peer-status ratings were developed on the basis of a procedure described by Cunningham and others (1, 2, 3, 4). Near the end of the 1960-1961 school year, pupils in each of four classes were asked to write (on a 3″ × 5″ card) the names of individuals in their class with whom they desired to work for committee assignments. On the card, pupils were asked to write the names of three persons and to indicate their preference among the three persons by marking their first choice 1; their second choice, 2; and their third choice, 3. On the reverse of the card, children were instructed to write the names of

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any persons (from their rooms) with whom they did not care to work. Children were told that no names had to be included on the reverse of the card; on the other hand, they could list as many names as they desired.

For each pupil, a single index that represented his peer-status rating (PSR) was computed. Such index was assumed to represent the social distance of the pupil from other members of his class. The PSR was a weighted composite of the choices made for each student by the other members of the class. Forty points were added to each composite to insure that all PSRs were positive. First choices were weighted 5; second choices were weighted 3; third choices, 1; negative choices, —4.

2. *Guidance Test Scores*

a. Intellectual capability. The total mental-scale *IQ* from the California Test of Mental Maturity, Short Form, 1957, was used. This test was administered in February, 1961.

b. Expected achievement. Expected achievement (*XA*) was a McCall *T*-score with a mean of 50 and a standard deviation of 10. Derived from the California Test of Mental Maturity (CTMM), expected achievement (*XA*) was computed as follows:

$$XA = 5/2 \text{ (Language score) } IQ + 1 \text{ (Nonlanguage score) } IQ$$

c. Achievement-test battery. Scores from the California achievement-test battery (CAT), administered in May, 1961, were utilized. Scores were (*a*) reading total, (*b*) arithmetic total, (*c*) language total, and (*d*) CAT total. Each of these scores was converted into a Mcall *T*-score.

d. Learning Efficiency Index. For each child, a learning efficiency index (*LEI*) was computed by the following formula:

$$LEI = XA - A + 30.$$

If the CAT total score were 10 or more points higher than *XA*, the pupil was considered an overachiever. If the CAT total score were 10 or more points lower than XA, the pupil was considered an underachiever.

e. Age. The life-age of each pupil was expressed in months, as of May, 1961.

D. FINDINGS

1. *Peer Status-Ratings*

From Table 1 it can be seen that there is practically no difference between the mean PSR's for the two grades.

TABLE 1

COMPARISON OF PEER RATINGS, *IQ*s, AND LEARNING EFFICIENCY FOR THE 5TH AND 6TH GRADE PUPILS ($N = 124$: 62 5TH AND 62 6TH GRADERS)

Grade and differences	Mean	Standard deviation
	IQ	
6th grade	109.00	15.02
5th grade	103.04	8.89
Differences	5.96	6.13
t values	2.71*	3.88**
	Peer Ratings	
6th grade	45.16	10.36
5th grade	44.61	11.25
Differences	0.55	—0.89
t values	0.28	0.68
	Learning Efficiency Index#	
6th grade	29.49	7.64
5th grade	32.60	6.64
Differences	—3.11	1.00
t values	2.39*	1.10

* Statistically significant at the 3 per cent level of confidence.
** Statistically significant at the 1 per cent level of confidence.
# A score of 30.00 represents average learning efficiency.

2. *Intelligence*

*IQ*s for pupils in the sixth grade are significantly higher than *IQ*s for pupils in the fifth grade; but the sixth-grade *IQ*s are more widely spread about their mean value than are fifth-grade *IQ*s. From Table 2, it can be seen that there is a significant positive relation between *PSR*s and *IQ*s. The brighter the pupil, the more popular he was with his class room peers. This relation was significant, however, only for pupils in the sixth grade.

TABLE 2

COMPARISON OF THE PEARSON *r* CORRELATIONS BETWEEN PEER RATINGS AND GUIDANCE TEST SCORES AND DATA FOR THE 5TH AND 6TH GRADE PUPILS

			The California Achievement Tests					
Data	Peer rating indexes	CTMM TMS *IQ*	Reading total	Arithmetic total	Language total	Total battery	Learning efficiency index	Age
			6th Grade ($N = 62$)					
Peer ratings		.33*	.29*	.31*	.23	.32*	.01	.18
Mean	45.16	109.00	54.35	57.16	53.31	55.07	29.49	12.2
SD	10.36	15.02	10.47	13.73	10.11	10.71	7.64	0.7
			5th Grade ($N = 62$)					
Peer ratings		.18	.32*	.26*	.40**	.36**	.13	.15
Mean	44.61	103.04	55.20	55.48	52.25	54.48	32.60	11.2
SD	11.25	8.89	8.63	8.41	8.93	7.80	6.64	0.5

* Significant at the .05 level of confidence.
** Significant at the .01 level of confidence.

3. *Achievement-Test Scores*

Table 2 shows significant positive relationships between *PSR*s and four CAT scores in the 5th grade and with three of the scores in the 6th grade. Thus, the most popular pupils are the pupils with the higher scores on the CAT battery.

4. *Learning Efficiency*

From Table 2 it is evident that only a chance relationship exists between peer-status ratings (PSRs) and learning-efficiency indexes (*LEI*s).

5. *Age*

Relationship between PSRs and life age was slightly positive in both grades (see Table 2), but in neither grade was statistical significance attained.

D. SUMMARY

This study consisted of comparative analyses of the relationships between peer-status ratings (PSR) and specified guidance data for pupils in the 5th and 6th grades. No significant differences were obtained in peer-status ratings between pupils in the two grades. The *IQ*s of the 6th-grade pupils was significantly higher and had more spread than was the case for 5th-grade pupils. For 6th-grade pupils, PSR, and *IQ* show significant positive relationship, but only a chance relation was obtained for pupils in the 5th grade. There is significant relationship between PSR and CAT scores in both grades, but no relationship between PSR and age. There was no relationship between PSRs and *LEI*s in either group.

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CHILDREN'S PERCEPTIONS OF SEX ROLES IN CHILDHOOD*[1]

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A. INTRODUCTION

The data reported in this paper were collected as part of an exploratory investigation of the development of children's concepts of adult sex roles. Perceptions of sex roles at the childhood level were included to help discover generalizing tendencies, if such tendencies exist, and to answer certain questions that seem basic to our understanding of the dynamics of sex-role internalization and development from childhood and adulthood. Among the questions, one of primary importance concerns the phenomonological aspects of sex-role activities from the child's point of view. We believed that we needed to find out, for example, to what extent children perceived differences in the respective sex-role implementation of their male and female peers before we could proceed to study their attitudes toward such roles and the quality of their indentifications with the roles appropriate to them as individuals. Subsidiary to this basic question was our interest in the possible association of four variables—sex, age, class background, and working status of the mother—with any differences in perceptions our subjects might show.

For an empirical study, one logical approach to the definition of roles seemed to be through the activities by which roles are expressed. Because we wished to sample as many aspects of child life as we could and wished to discover whatever parallels to adult sex roles we could, we felt we had to go beyond the simple toy scales used by Rabban (3) and by Brown (1) prior to the start of our study.

Our subjects were boys and girls, 5, 8, and 11 years old, from upper middle- and lower middle-class backgrounds. All were from New York City.

To accommodate to the age spread of the children, we decided to use a structured pictorial technique as an interview aid, as well as open-ended ver-

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bal questions. The contents of the pictorial technique, called "Role Distribution: Children's Series" (RDC), was dictated by the age of the children. Our aim was to obtain as broad a definition as possible—given the urban background of the subjects and the variation in their social background.

The instrument consisted of a group of pictures of key items in 56 different activities that sampled aspects of play and recreation, peer contacts, participation in parental activities, domestic chores, intrafamily relationships, and "cultural" activities. The open-ended query was included in the hope that it might illuminate the relative saliency of specific sex-role differentiators and possibly add to our understanding of identification processes in the middle years. It was hoped that it would do this by indicating relative levels of awareness of the role activities appropriate to one's own sex and those appropriate to the opposite sex.

In this report, the authors will refer only to the data elicited from the 8- and 11-year-old subjects, 91 girls and 40 boys, approximately evenly divided by age, social background, and working status of their mothers. All children came from two-parent homes and all had been born in the United States. Minority group members and children with outstanding emotional problems were avoided.

B. Procedure

In the Role-Distribution Measure, the pictures were grouped for convenience of administration into those that pertained to (*a*) loci of play, (*b*) things to play with, and (*c*) other activities including tasks and services.

In individual sessions, the interviewer introduced each group of pictures by saying, as was appropriate, "I am going to show you some pictures of places where boys and girls play (things boys and girls play with; things boys and girls do). As I show you each picture I want you to tell me who mostly plays there (plays with it; does it), boys, or girls,—or both or neither."

The pictures were presented in sequence, with a verbal description for each; for example, "This is a park—who mostly plays there?" "Here are some marbles—who mostly plays with them?" "Here is a man fixing a ceiling—who mostly would help him?" See Table 1 for the full list of items.

The open-ended query was presented in this way: "Suppose you met a person from Mars who knew nothing about the way we live here, and that person asked you to tell about girls in this world—what would you say girls need to know and be able to do? What would you say boys need to know and be able to do?"

TABLE 1
ITEMS COMPRISING ROLE DISTRIBUTION, CHILDREN SERIES

Item	Description of activity
1	Playing on playground
2	Playing on roofs
3	Playing on sidewalks
4	Playing in railroad yards
5	Playing at beach
6	Playing in basement
7	Playing in park
8	Playing in street
9	Playing in playroom
10	Playing in messy empty lot
11	Playing on docks
12	Playing in country fields
13	Carrying wood into house
14	Caring for baby when parents away
15	Going with man to ball game
16	Taking dancing lessons
17	Shoveling snow off walk
18	Bringing mother drink
19	Emptying wastebasket
20	Tidying up room
21	Helping man fix ceiling
22	Being sent to get groceries
23	Washing dishes
24	Playing with little boy
25	Clearing table after meal
26	Greeting parents with a kiss
27	Climbing trees
28	Protecting frightened little girl
29	Helping mother hang clothes
30	Reciting for guests, at home
31	Being taken out for a ride by mother
32	Hitching ride on back of truck
33	Drying dishes
34	Helping woman carry packages
35	Dusting table
36	omitted
37	Playing with little girl
38	Playing with toy air-rifle
39	Playing with erector set
40	Playing with toy sewing machine
41	Playing with wagon
42	Playing with electric train
43	Playing with toy dishes
44	Playing with marbles
45	Playing with ball and bat
46	Playing with toy carpet sweeper
47	Playing with toy pocketbook
48	Owning and taking care of puppy
49	Playing with toy electric mixer
50	Playing with drums
51	Playing with jacks
52	Playing with toy trucks
53	Playing with doll carriage
54	Playing with toy tool bench
55	Playing with fort and soldiers
56	Playing with jump rope
57	Playing with jack-knife

C. ANALYSIS OF DATA

Responses to the items in the RDC series were tabulated according to the categories indicated by the subjects. For each item the response of highest frequency was compared with the sum of all other responses given. Attributions in excess of 50 per cent of the sample that, in terms of chi square, show deviations from chance at a p level of .05 or less are regarded as consensual.

For the purpose of examining the possible effect of sex of respondent, social class, age, and the working status of the mother, respectively, subgroups matched on all the selected variables except the one in question were drawn from the total sample and their response distributions were compared.

Of the four pairs of subgroups, three were composed entirely of girls. The selected groups used in the respective comparisons varied in numbers as follows. For comparisons that involved sex differences (34 males and 34 females); for age comparisons (28 eight-year-olds and 28 eleven-year-olds); for class (28 each of upper middle- and lower middle-class subjects); mother's working status (20 with working mothers and 20 with nonworking mothers). For each of the items, the effect of each variable was determined by ascertaining the response of highest frequency in each of the two subject subgroups involved in the particular test and by evaluating the differences in distributions by the chi-square test (2).

Because of some of the results, two other types of analysis were applied to the RDC responses. To test for the possible operation of a generalized tendency toward egalitarianism or sex-typing, the split-half reliability of responses categorized as egalitarian (both, neither, either) or sex-typing (clear male or female attribution) was ascertained. According to our four-variable test subgroups, comparisons of group tendencies were made, and differences were tested for significance. Second, the 20 items that involved toys and playthings were chosen for a special test of the stability of their comparative sex-typing power. The items were rank ordered according to the proportion of egalitarian "boy" and "girl" responses given by our selected sex-comparison and age-comparison groups, respectively. Rank difference correlations were computed for each of the three categories of response, based on the boys' and the girls' responses and on the responses of the 8-year-old children and the 11-year-old children (all girls), respectively.

Analysis of responses to the "Mars" story was in terms of the number of items mentioned by each subject for boys and for girls. Each subjects' item-mention score was tabulated, and distributions of scores were prepared separately for each referrent and for each subject sex group. The chi-square test was used to evaluate the differences between the boys and the girls.

D. Results

Based on our total sample of 131 subjects, 46 items (out of 56) meet the criterion of consensuality and 40 of these show clear-cut specific sex attributions. Seventeen items were assigned to girls, 23 to boys, and six to both sexes. Calculated on the basis of the male and female samples, separately, these figures became 16, 20, and 5, respectively. Ten items that failed to attain consensuality in the total sample were as follows: being sent to get groceries, tidying up a room, being taken out for a ride by mother, reciting for guests at home, helping a woman to carry packages, playing in a basement, protecting a frightened little girl, emptying wastebaskets in the home, playing in a playroom, and playing on the sidewalk. In addition, when responses of boys and girls are considered separately, the following items failed to meet the criterion for consensuality in at least one group: brings mother a drink, playing on docks, playing in a railroad yard, playing with a coaster-wagon, and kissing parents on coming home. See Table 2 for items that exhibit consensuality in both male and female samples.

Of the top 50 per cent of items that show the greatest consensuality among the activities attributed to girls, six concern playthings. Of the top 50 per cent of boys' attributions, eight refer to playthings. The proportions are the same in each case; about two-thirds of the top items.

The high degree of consensuality awarded the toy items led us to test for the stability of their comparative sex-typing power. The results of the latter test were as follows: (*a*) for the boy and girl samples, a correlation of .92 on the male attributions, of .89 on the female attributions, and of .86 on the egalitarian responses; (*b*) for the 8- and 11-year-old children, a correlation of .89 for the male attributions, of .79 for the female attributions, and of .75 for the egalitarian responses. In terms of sex-typing power, these results suggest that specific playthings occupy a stable hierarchy in the culture and suggest that this hierarchy is perceived similarly by boys and by girls, and by 8- and by 11-year-old children. More change is shown with age for the female attributions than for the male. This result suggests that the male attributions are established earlier.

It is worth noting also that, within the upper half of the sex-attributed items, there is greater consensuality in the female attributions at every item position. This result suggests a greater perceptual exclusiveness for the female items.

Comparisons for detecting the effects on individual items of the four variables mentioned earlier give the following statistically significant differences.

1. *Comparison by Sex*

a. Bringing a drink to mother. 74 per cent of the girls said this is done mostly by girls, 44 per cent of the boys agreed.

b. Being sent for groceries. 65 per cent of the girls claimed this for their sex, 38 per cent of the boys said "both."

c. Emptying wastebaskets. 46 per cent of the boys claimed this for their sex, more girls said "both."

d. Protecting a little girl. 73 per cent of the boys attributed this to males, only 39 per cent of the girls agreed.

TABLE 2

ROLE DISTRIBUTION, CHILDREN SERIES: PERCEIVED IMPLEMENTATION OF ACTIVITIES AND ROLE-BEHAVIORS HAVING CONSENSUALITY AND ATTAINING STATISTICAL SIGNIFICANCE IN BOTH FEMALE AND MALE SAMPLES

Item	Description of activity	Percentage of attribution Female sample	 Male sample
	A. Implemented mostly by girls		
53	plays with doll carriage	100.0[a]	100.0[a]
40	plays with toy sewing machine	98.9[a]	97.5[a]
43	plays with toy dishes	96.7[a]	100.0[a]
46	plays with toy carpet sweeper	95.6[a]	92.5[a]
47	plays with toy pocketbook	94.4[a]	97.5[a]
49	plays with toy electric mixer	91.0[a]	87.5[a]
29	helps mother hang clothes	90.0[a]	82.5[a]
37	plays with little girl	88.8[a]	90.0[a]
14	cares for baby when parents away	87.8[a]	85.0[a]
35	dusts table	86.7[a]	72.5[b]
56	plays with jump rope	81.1[a]	90.0[a]
33	dries dishes	78.9[a]	68.4[c]
23	washes dishes	77.8[a]	80.0[a]
25	clears table	73.3[a]	72.5[b]
16	takes dancing lessons	65.6[b]	70.0[c]
51	plays with jacks	64.4[b]	72.5[b]
	B. Implemented mostly by boys		
38	plays with toy air-rifle	94.4[a]	95.0[a]
32	hitches ride on back of truck	91.1[a]	82.5[a]
52	plays with toy trucks	91.1[a]	90.0[a]
55	plays with fort and soldiers	90.0[a]	97.4[a]
21	helps man fix ceiling	86.5[a]	92.5[a]
45	plays with ball and bat	81.1[a]	92.3[a]
13	carries wood into house	80.0[a]	90.0[a]
27	climbs trees	80.0[a]	90.0[a]
54	plays with toy tool bench	80.0[a]	92.5[a]
24	plays with little boy	79.5[a]	77.5[a]
50	plays with drums	78.9[a]	77.5[a]
57	plays with jack-knife	78.7[a]	95.0[a]
39	plays with erector set	76.7[a]	82.5[a]
15	goes with man to ballgame	76.4[a]	70.0[c]
10	plays in messy empty lot	75.6[a]	72.5[b]
8	plays in street	74.7[a]	77.5[a]
42	plays with electric train	73.3[a]	85.0[a]
17	shovels snow off walk	66.7[b]	75.0[b]
44	plays with marbles	66.7[b]	72.5[b]
2	plays on roofs	63.3[c]	70.0[c]
	C. Implemented by both sexes		
5	plays at beach	84.4[a]	94.5[a]
12	plays in country fields	72.2[a]	72.5[b]
1	plays on playground	69.2[a]	75.0[b]
48	owns and takes care of puppy	65.2[b]	56.4[c]
7	plays in park	63.7[b]	72.5[c]

[a] Probability is beyond the .001 level.

[b] Probability lies between the .01 and the .001 levels.

[c] Probability lies between the .05 and the .01 levels.

e. Playing with a jump rope. 91 per cent of the boys attributed this to females, only 71 per cent of the girls did so.

2. *Comparison by Age*

a. Accompanying a man to a ball game. 88 per cent of the 8-year-olds saw this as a boy's activity, only 61 per cent of the 11-year-olds did.

b. Playing with a ball and bat. 93 per cent of the younger girls attributed this to boys, only 71 per cent of the 11-year-olds did.

3. *Comparison by Class*

a. Taking dancing lessons. 84 per cent of the upper middle-class sample attributed this to girls, versus 47 per cent of the lower middle-class group.

b. Playing with jacks. 90 per cent of the upper middle-class sample assigned this to girls, only 50 per cent of the lower middle-class did.

c. Tidying a room. 84 per cent of the lower middle-class sample assigned this to girls, only 47 per cent of the upper middle-class did.

b. Climbing trees. 95 per cent of the lower middle-class sample restricted this to boys, only 63 per cent of the upper middle-class agreed.

4. *Comparison by Maternal Work Status*

a. Climbing trees. More daughters of nonworking mothers saw climbing trees as specifically a boy's activity (95 per cent *vs.* 58 per cent).

b. Playing with a ball and bat. More daughters of nonworking mothers saw playing with ball and bat as specifically a boy's activity (95 per cent *vs.* 60 per cent).

E. TRENDS

Although little in the way of trends can be detected in the item differences, the inquiry into generalizing tendencies had interesting results. Egalitarian responses show a split-half reliability coefficient of .84 (with Spearman-Brown correction). A range from 0 to 70 per cent of all responses indicates wide individual differences in the tendency to sex-type activities. While comparisons of group tendencies, according to our four variables, reveal no significant differences, the largest difference ($p < .20$) comes from the class comparison, with the lower middle-class subjects unexpectedly showing *more* egalitarian responses.

In response to the "Mars" story, girls mentioned significantly more items for the girls than they did for the boys ($p < .001$). Boys mentioned approximately equal numbers of items for each sex. Compared with the girls, boys mentioned significantly more items for male roles ($p < .01$). They also mentioned significantly more items for female roles than girls did for male roles, while they equalled the girls in female-role item-mentions.

F. Conclusions

From the Role-Distribution data the following conclusions seem warranted:

Children perceive clear-cut differences in sex-role implementation at the peer level.

There exists a fairly broad scope of activities the implementation of which is perceived differently by different individuals, so that a consensual designation for them is difficult to establish. Because these are made up largely of loci of play and family service items, it is likely that these activities have no culture-wide assignment, but are defined locally, either by neighborhood or family, in terms of the individual situation.

Playthings seem to be most clearly defined perceptually as indicators of sex roles in childhood. What boys play with seems to be reliably established earlier than what girls play with. The greater consensuality attendant on girls' toy designations suggests that these are characterized by more rigid tabus for the opposite sex than are boys' toys.

Female sex-role activities in childhood seem to parallel specific traditional adult female-role activities to a greater extent than male-role activities in childhood parallel adult male-role activities, in an urban milieu.

In terms of the variables we studied, sex of respondent is apparently most important in influencing role perception. The significant differences in response mainly showed a tendency on the part of each sex to claim more participation in certain activities than attributed by the opposite sex. This is reminiscent of Piaget's egocentrism and of Lerner's ethnocentrism.

Class background, though associated with more significant differences in item responses than age or mother's work status, shows no consistent direction of influence. Upper-middle class subjects sex typed two activities less than did lower middle-class subjects and reversed this relationship on two other items.

Neither age nor mother's work status seems to influence perception of children's sex-role assignments to any notable extent.

While girls seem to be selectively more aware of girls' roles, compared with their awareness of boys' roles, boys seem to be equally aware of both. This selectivity seems to disagree with the common assumption that boys are not interested in girls' activities during the preadolescent years and seems to support an hypothesis suggested elsewhere by one of the investigators (2) that, in contrast to sex-role development in girls, the dynamics of the negative directive plays a leading part in the development of the sex identification of the boy, forcing an awareness of opposite sex-role activities for the purpose of avoiding them.

G. SUMMARY

This paper reports an investigation of children's perceptions of peer-age sex roles, using one structured pictorial technique (called "Role Distribution") and one open-ended type question (the "Mars" story). Subjects were 40 boys and 91 girls, 8, and 11 years old, of urban background. Subgroups matched on pertinent variables were used to examine the effects of sex, age, class, and mother's work status. Results indicate that children distinguish clearly between boys' and girls' sex-role activities, that toy items have great stability as sex-role indicators, that a generalized tendency toward sex typing or egalitarianism may exist, and that individuals differ greatly in this tendency. The four variables examined seem to exert little influence on the subject's perceptions of sex roles within the limits of the Role-Distribution items. On the open-ended question, boys seem equally sensitive to male and to female peer-age roles, as sensitive to female roles as are girls, and more aware of female roles than are girls of male roles. It is suggested that a negative directive plays a greater part in boys' sex-role identification forcing an awareness of opposite sex-role activities for the purpose of avoiding them.

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THE PSYCHOLOGY OF THE METAPHOR*

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A. INTRODUCTION

Hebb (59) has suggested that we forge ahead with the study of those cognitive or mediational processes seemingly not reducible to behavioristic conceptions. This account of the psychology of the metaphor is designed as a contribution to this end.

Linguistic metaphor can be defined as the application of a word or expression that properly belongs to one context to express meaning in a different context because of some real or implied similarity in the referents involved (30; 103, p. 135). Its correlated mediational processes represent a fundamental way in which an organism makes sense of input by formulating new experiences on the analogy of the old (27, p. 206; 36, pp. 94-95; 46, p. 70). For example Lee (73, p. 357), when he reviewed all of Malinowski's papers on language, noted that Trobrianders had no word to express a causal relationship.

> The Trobriander had no linguistic mechanism for expressing a relationship between events or acts—in his culture, the sequence of events does not automatically fall into the mould of causal or telic relationship . . . The word which he (Malinowski) translates as 'cause' or 'reason' means 'the lowest part of the trunk.' Now a trunk is that which precedes the branches spatially and temporally, and we can hardly maintain that the trunk is the 'cause' of the branches, or the 'reason' for the branches. The word in question 'u'úla,' is used metaphorically, as elsewhere in this region, to refer to the organiser of a ceremony, as well as to the indispensable first section of a magical formula. Underlying these meanings must be a concept of a basis, or a necessary precedence.

More specifically, Ribot (89, pp. 28-29) contends that the processes underlying metaphor are relevant to industrial, scientific, and commercial invention; and Koestler (71) concludes that metaphorical juxtaposition of two contexts is a common factor in the genesis of wit and scientific discovery. Indeed, the psychology of metaphor is one way of promoting that linkage be-

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tween psychology and the humanities recommended by Asch (5, p. 94) and by Koch (70, pp. 629-630).

There are various superficial forms of metaphor—personification, symbolism, synaesthesia—but underlying all of them is the sort of categorizing and analogical reasoning that Richards (90, pp. 48-49), Turner (106), and Bruner (23, 24) make plain is fundamental to all thinking, and especially to creative thinking.

B. Previous Orientations

Throughout the cultural history of western civilization, reference to the metaphor has been scattered but persistent. Stanford (102) has reviewed classical accounts, but of these only Aristotle's perceptive speculations (30, 63) have any relevance for psychology. According to Aristotle (63, p. 173), the metaphor describes "an active state"; it involves "surprise" in the sense that it upsets expectations (63, p. 173); it contains a resolved double meaning that is a great source of its aesthetic effect (63, p. 175); and it is an important component of apparently discrepant forms such as puns, riddles, proverbs, and hyperboles (63, pp. 173-176). These points will be assimilated into a systematic account of metaphor to be presented.

As the mediaeval world disappeared in the face of scientific and technological advances, and the symbolic way of conceiving experience described by Barfield (13) became a disreputable fiction to empiricists who took the view that the "hard facts" of the external world are given to consciousness in a finished state without being transformed (on the way) by any activity on the part of the organism (20, pp. 73-75; 17), and that the main object of language as a system conducive to correct thinking is to "picture" and "mirror" these facts accurately (38), so the metaphor was classified as a literary embellishment designed to dupe the unwary. Bacon placed metaphors among the "phantasies of the market-place" (7, p. 20), a position followed by Hobbes, Sprat, Locke, and Hume.[1] This tradition was carried on and extended by Bentham [see Ogden (79)] who regarded metaphor as a ruse invented by rulers to dominate their subjects more easily. Bentham distinguished between "real perceptible entities" that ". . . are made known to human beings by the immediate testimony of their senses . . ." (79, p. 7) and "fictions" or fictitious constructions that are "nonentities" with no existence. Unfortunately, an "existence" is sometimes ascribed to these fictions by the metaphorical process that Bentham calls "paraphrasis," which is described as the ". . . transmuting into a proposition, having for its subject some real entity, a proposition which has not for its subject any other than a fictitious entity" (79, p. 86). Occasionally, a reading of these metaphorical propositions redintegrates ". . . some real action or state of things" (79, p. 87), which reading lends substance to what is otherwise a mere fiction or allegory and which may suitably be used to subvert rational and unbiased decision (79, p. 18). Bentham even claims that physical force lurks behind political "dead metaphors" such as "obligation," "right," "power," "privilege," and "prohibition," which, as a result, shape behavior—a view shared by Embler (41, p. 128).

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[1] Berkeley, in a different philosophic tradition, had the same dislike of metaphor.

1. *The Freudian Orientation*

The consequent restriction of the study of metaphor to the context of literary evaluation and speculation of an untestable sort (12, 122) has been prevented by three movements: the Freudian, the philosophical neo-idealism of Cassirer and his associates, and experimental psychology. Each of these movements has contributed independently to a convergent model of behavior of general significance. The Freudian approach was formalized by Jones (64), who drew a distinction between two kinds of metaphor: Freudian symbolism, and "metaphorical" or "functional" symbolism. The latter sort, in which Richards' concrete term, "metaphorical vehicle" (90), describes a psychological function or experience, was originally studied by Silberer (94, 95), who believed that it appeared as a regression to a more pictorial level of thinking under conditions of comparative disinhibition and loss of control of the abstraction apparatus (96, pp. 216-217), as in a fatigued or neurotic state (94, pp. 196-197).

By contrast, in Freudian symbolism, the concrete term refers to a bodily (usually sexual) organ, or process, or activity (conscious reference to which is repressed), and the preference for the "functional" or "metaphorical" interpretation represents a "resistance" to the sexual interpretation. Metaphor has a function similar to the dream in that it is a form of elaborated symbolic disguise that reduces the "psychic tension" associated with the repressed libidinal urges. Metaphor is a verbal manifestation of the larger symbolic intent of the individual and is to be differentiated from symbolism largely because it has an everyday, decoy meaning in addition to its more symbolic one. Indeed, it was Freud's characteristic practice to understand his patient's condition by fastening on to the symbolic significance of his patient's metaphors, as in his analysis of Dora (47, pp. 58-59).

This indirect sexual interpretation of metaphors is illustrated by Abraham (1, p. 429) and has been elaborated and extended to apply to metaphor directly, by Sharpe (93). For Sharpe, the metaphor is simply a concentrated piece of symbolism in which the genuine erotic interpretation is made more overt than in normal symbolism by being carried in words and phrases that also carry a meaning not undesirable from a social standpoint. For example, one of Sharpe's patients said, "When I wander off the point bring me back to it." The latent metaphorical meaning was a desire to return to early sucking at the mother's breast. The libidinal gratification provided by this sort of metaphor occurs because the metaphorical vehicle stands for an object or process of erotic significance, specifically, the bodily experiences (oral, anal, urethral, and genital) and the emotional experiences of the young child before its powers of control have been established (93, pp. 142-143). When the child is no longer allowed to relieve his "mental tension" by "physical discharge," as he formerly did, he resorts to "mental discharge" by speech and finds substitute gratification by using in speech the physical or bodily terms that have a double reference to "mental processes" and to early erotogenic experiences (93, p. 156).

The examples that Sharpe gives to illustrate her thesis—"I see your point of view, but I don't take it in." and "This couch reeks of verbosity." and "I'm terrified of making a mess of things."—form the basis of the Harvard Anal Disposition Scale administered by Couch and Keniston (37), and it is hardly surprising that their speculation about the origin of "yeasaying," which is correlated significantly with preference for metaphorical usage, is identical with Sharpe's theory concerning the origin of metaphor. A good illustration of the Sharpe, and of the Couch and Keniston, position is found in Luther, whose anal profanity against the Devil and the Pope has been traced [by Erikson (42, pp. 239-240)] to Luther's harsh upbringing, especially in matters of cleanliness and toilet training. Luther's rebellious attitude probably took the original form of anal activity and then, later, of partial sublimation in anal metaphor; and this verbal transformation of "anal defiance," acting as a safety valve (42, p. 240), was then transferred to all authority figures when overwhelming hostile arousal against them built up. Baker (8, 9, 10, 11), like Fodor (45, p. 300) has also documented this theory by a consideration of the psychopathology of everyday linguistic behavior. If metaphor arises in this way as a compromise formation and provides both libidinal and respectable meanings, then it can be predicted that metaphors of a euphemistic and circumlocutory sort will rise to replace a word or phrase directly expressing an object, event, or experience that is taboo. Baker (8, 9) and Werner (115) provide striking illustrations of this theme.

Isaacs (61, p. 109) stresses the oral origin of some metaphor. This is Freud's "language of the oral instinctual impulses" (48, p. 183), manifested in the metaphors: "I should like to eat that or I should like to spit it out," or "I should like to take this into me and keep that out of me" (48, p. 183).

The latest writer on metaphor and Freudian theory is Brown (21), who presents compelling evidence that the thinking and the language of Swift, as well as of Luther, were characterized by anal eroticism. However, he objects to what he terms ". . . the vulgar psychoanalytical derivation of anal character from the experience of toilet training" (21, p. 288). Borrowing largely from Freud's later conclusion that the anal-erotic processes do not lose their importance in the sexual life after the establishment of complete genital primacy (49, p. 165), and from the conclusion that the powerful hold of anal eroticism can be seen in phantasies about faeces and in their symbolic equivalents (49, p. 166), Brown presents a sweeping psychoanalytic hypothesis to the effect that adult sublimation and negation, at its root, ". . . confers an anal quality upon the entire life in culture" (21, p. 295; 48). This implies that the distinctive cues that activate metaphor in any repressive society are of a disproportionately anal sort.

2. *The Aesthetic Approach*

A philosophical account of metaphor (72) with a psychological branch (5, 6, 67, 116, 117) originates with Cassirer (33, 34, 35), who hypothesises that the linguistic metaphor and myth (34, p. 88) and their correlative "metaphorical thinking" are the products of some postulated undifferentiated primitive state of symbolic consciousness (33, p. 37). Werner (117, p. 67), in an attempt to translate this concept into testable terms, has equated it with "motor-affective reactivity of the organism," which is manifested in "physiognomic perception" (117, p. 69). In Werner's hands, this concept is a product of circular inference exclusively. After having attributed to it dynamic properties, he then takes it to explain the incidence of personification and anthropomorphism (117, pp. 75, 77), metaphors describing the unity of feeling and physical experience (117, pp. 83-85), synaesthetic metaphors (117, pp. 86-87), and so on. Gombrich's attempt (51, p. 232) to relate "physiognomic perception" to evaluative attitudes of an Osgoodian sort is still subject to this tautological stricture.

The problem is not the incidence of dynamic linguistic phenomena—Downey (40, p. 62) provides a good example—but an adequate explanation in noncircular terms. As Brown (22, pp. 152-153) has indicated, Osgood's concept of mediation may be used here. Werner (117, pp. 259-260) demonstrates that a high pitch may express something fine, small, tender, secret. In Osgood's theorising, these signs would be equated because they activate the same mediational process, and they do so because they are conditioned to the same significate that provoked the original response of which the mediational process is a fractional part. Brown points to the high probability that high pitch in practice will be associated with things that have the property of being fine, small, tender, and so on; while the obverse is true of low pitch. Most of the detailed illustrations and findings with which Werner (116) has tried to buttress the concept of "physiognomic perception" and its rationale in the shape of the sensori-tonic theory of perception (113, 118, 119, 120) are reducible to simpler noncircular conceptions free from the "somewhat metaphysical urge" that Allport (3, p. 200) suggests has promoted the postulation of this original undifferentiated state.

Langer's translation (72) of Cassirer can also be converted into Osgood's terms, with some help from Bruner. For Langer (72, p. 145), the "figure-making consciousness" is manifested in images by means of which we try to conceptualize new experiences that threaten to overwhelm us.

> Fire is a natural symbol of life and passion. . . . Its mobility and flare, its heat and colour, make it an irresistible symbol of all that is living, feeling and active. Images are, therefore, our readiest instruments for abstracting concepts from the tumbling stream of actual impressions. They make our primitive abstractions for us, they are our spontaneous embodiments of general ideas.

The concept of "images" is very similar to the use of the term by Miller, Galanter, and Pribram, to mean organized cognitive models (76, pp. 17-18) and the function attributed to them (by Langer) is in line with Bruner's contention (27) that it is psychologically compulsory for an individual to make sense of his world, a point given physiological backing in Berlyne's demonstration that the unfamiliar, the incongruous, and the inexplicable induce arousal which the organism must correct by marshalling all its powers and achievements (16). And fire is the "natural" symbol of life (in Osgood's terms) because life and fire have common properties (heat *vs.* the cold of death, color, movement, and so on) and hence have a common affective meaning.

In short, the metaphorical consciousness is some sort of roused state that finds satisfactory expression in, among other ways, metaphorical products, a conception that does justice to Cassier's conception (35, p. 88), especially as interpreted by Wheelwright (122, pp. 115-159).

C. Some Experimental Findings

Early experimental work about the metaphor yielded a trickle of findings that can be assimilated into a model. Sterzinger (104) analyzed the reactions of experimental subjects to batteries of metaphoric expressions and inferred that the pleasure in metaphor comes from the "Unterschiebungen" or metaphorical "substitution" or "forging." A more impressive paper on the same theme is by Staehlin (101, who points to the fact that the "meaning-experience," Bedeutungserlebnis, of a word requires a certain quality of awareness on "level of understanding," Bewusstseinslage des Verstehens or "level of consciousness," Bewusstseinslage (101, p. 313), and the particular "level of understanding" appropriate for metaphor is the awareness of a double meaning, Bewusstseinslage der doppelten Bedeutung, which comprises the literal or contextual meaning and the figurative meaning (101, p. 321). This awareness of the double meaning, which can be called the "level of metaphoric understanding," Bewusstseinslage des metaphorischen Verstehens, promotes the reduction of tension by a conceptual resolution that refers to the unique appositeness of "blending" of the metaphor. Karwoski, Odbert, and Osgood (68, p. 204) conclude that this "blending," or what they term "the parallel alignment of two gradients," must be learned, and any psychological model of metaphor must consider the origins of this sort of linguistic preference (motivational and personality aspect) and how the gradients are aligned (learning aspect).

D. A Cognitive Model

1. *Berlyne's Contribution*

The immediately relevant motivational theorist to contribute to the model is Berlyne, who begins with the functionalist assumption that perceptual and intellectual processes are biologically advantageous in that they are either immediate or delayed ways of reducing conflict, tension, or arousal (16, p. 6). Berlyne demonstrates that certain stimulus variables (novelty, "surprisingness," incongruity, ambiguity and uncertainty, and complexity) activate the orienting reflex, or vigilance (16, pp. 83-86) and thereby induce a degree of arousal that forces the individual to reduce that arousal back to a tolerable level. This maintenance of an optimal arousal level or steady state (16, p. 200) is carried out largely by cortical activity (16, p. 181), although the nature of this interaction between cortex and arousal system has still to be settled.[2]

According to Berlyne's model, all reinforcement is primary and takes the form of arousal-reduction; the organism has neither a need for, say, good nor for achievement, but only for a reduction in the arousal that it has learned to associate with absence of good and of achievement. Occasionally, the organism will seek incentives with arousal value, incentives which will provide "arousal jags" (16, pp. 198-199), but only provided the arousal-increase is moderate and has a high probability of being followed by arousal-decrease. Platt (86) has provided massive evidence for the hypothesis that ". . . our response system demands new information or novelty, and yet at the same demands regularity or pattern" (86, p. 405). A moderate degree of uncertainty, in other words, makes life less dull (16, p. 207), a point attested by Skinner (97) and by Cantril and Bumstead (31). The converse of the arousal jag is boredom, which occurs when there is a rise in arousal with no available means of arousal-reduction. In the case of the experiments on sensory deprivation, the rise in arousal level is explained as a product of the fact that inhibiting impulses from the cortex, which normally dampen arousal, are inactivated as a result of the monotonous stimulation, an event that releases the arousal system from cortical restraint (16, p. 191).

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[2] Berlyne sees the cortex as primarily arousal-reducing, Hebb sees it as arousal-inducing.

According to this motivational model, a desirable incentive is an incentive that can provoke an arousal jag: i.e., an incentive that can induce arousal and guarantee its immediate reduction. The metaphor can certainly be categorized in this way. By its linkage of normally disparate states or events, the metaphor is characteristically novel and incongruous; hence it induces arousal. And by the provision of some conceptual resolution in the opposite and appropriate use of this blend of the disparate, it sets off arousal-reduction. This represents a reasonable formulation of the accounts of metaphor proposed by Aristotle, Sterzinger, Staehlin, and Downey.

2. *Bruner's Contribution*

A second aspect of the model must deal with the symbolic-cognitive activity underlying metaphor and yet must be capable of establishing links with Berlyne. Bruner (23, 24, 25, 26) assumes with Berlyne that man's basic task is to reduce the arousal associated with the "surprise value of the environment" (23, p. 133), particularly the presence of new problems not to be solved by old habits and contingencies. A useful way of doing this is to construct a working model of the essential features of the environment (26)—with all its stabilizing and economical properties (23, p. 123; 26, p. 209), especially with its advantage of enabling one to go "beyond the information given"—to extrapolate and predict events and behavior beyond the confines of the data from which the model was derived (25, pp. 45-46; 26, p. 200). Bruner (24, p. 48) claims that this going beyond the information given can be described as having a "metaphoric idea" or a "combinatorial idea," which is clearly identical with the perception of a common structure that links different domains or different areas within a domain (24). This structure may be mathematical, as indicated by Turner (106) in his account of "physical analogy" in the thinking of nineteenth-century scientists; or it may be practical (24, pp. 63-64) or psychological, involving a sudden perception of individual points of correspondence in a behavioral context (he was a lion in the fight) or a long and articulated pattern of relationships, as in symbolism. Bruner (25, p. 48) provides an example of the latter in Giotto's twelfth-century painting of Christ on the crucifix. This painting is not heavily stylized like earlier paintings, but is metaphorical in the sense that the figure on the cross represents both an ascetic deity and man.

> The combinational genius of Giotto was to join together the plight of man and the suffering of Christ in a way that gave a new breadth to the meaning of Christ and to the meaning of man. The achievement is a metaphoric one, a joining together metaphorically of man and God that enriches the conception of both and creates the possibility of going beyond conceptions that existed the moment before. This is how ideas are forged—great ideas—whether in art or science—or in any sphere.

This is similar to Richards' views already noted and to Werner's "metaphorical concepts" (117, pp. 243-245).

If Hebb's preference for a single-drive theory of motivation is accepted (61, p. 159) and "emotion" is taken as roughly coextensive with the gradient of supranormal arousal, Bruner's link with Berlyne is obvious. Bruner contends that a flow of metaphors is stimulated by impulses. There is a two-way relationship, then, between the production of metaphor and the incidence of "impulses:" a metaphor can touch off these "impulses," presumably, in someone who is "motivationally open" to arousal; and the roused individual can also search out metaphors to express and assuage his state.

> . . . good operational ideas very often have their origin in highly personal metaphors that express deep-lying impulses in the person, metaphors that have about them some of the character of great myths and legends. It would seem as if the arousal of an impulse . . . sets loose a stream of loosely-related images and memories, provided that the impulse is in its full expression. This flow of ideas is a substitute for overt action in behalf of the impulse. It is perhaps even a kind of wishful action of the kind Freud referred to as primary process—almost as in dreaming (25, p. 49).

In her report of an experiment in which an attempt was made by a group leader to elicit "metaphoric ideas" at the beginning of a session on creative thinking, Mawardi (75) has also pointed out that the evocation of feeling states facilitates the production of metaphor. The leader's call for the production of "feeling words," combined with the surprising incongruity at the basis of the early metaphors, is reported by Mawardi to have so "stimulated the unconscious" and to have so "shaken the person out of a rut" that "new syntheses" appeared.

However, this is not quite good enough and questions arise. First, how does arousal operate to link, metaphorically, states or events not habitually associated previously? How are arousal experiences converted into metaphor? Second, can Bruner's cognitive approach to metaphor be reinforced by the scrutiny of a behaviorist who is liberal enough to undertake consideration of such a symbolic activity? This is not too incongruous because, in the quotation from Bruner just given, there is implication that "metaphoric ideas" have a concomitant motor response.

3. *Osgood's Contribution*

Osgood (80, 81, 82, 83) and Osgood, Suci, and Tannenbaum (84) contend that meaning occurs when the presentation of a sign, which has been associated with a significate, elicits a fraction of the response elicited by the significate. Or, in freer cognitive terms, meaning appears when a sign and a significate or two signs or possibly two assigns share a common mediated response. Words, then, ". . . represent things and evoke meanings because they produce in human organisms some replica of the actual behavior towards these things, as a mediation process (84, p. 7), a position strikingly similar to that advocated by Bentham (79, p. 61). From this behavioristic standpoint, therefore, metaphor arises when there is an interchange of words or expressions that evoke the same meaning or representational mediational process because they are attached either directly or indirectly to different properties of the same significate. For example, Osgood (80, p. 644) reports a synaesthetic linkage of "large" with "loud," and experience of synonymity based on the fact that significates that are large tend also to be loud. Osgood's other example of "near" linked with "fast," "bright" with "happy," and "treble" with "up," and those of Simpson, Quinn, and Ausubel (96) are also explicable in the same way.

Questions concerning the compatibility of Osgood's and of Berlyne's theorizing and of Osgood's view of the conversion of arousal into metaphor can be answered by pointing to the fact that arousal for Osgood is closely linked to the mediational process which, as a good Hullian, he regards as comprising two inextricable components, the fractional anticipatory response (r_m) to the sign and the internal cue (s_m) produced by that response. The internal cue has two functions: the reinforcing of the motivational state by feedback to the r_m, and the activation of the instrumental sequences selectively associated with the sign. Osgood believes that the r_m component of the mediational process is bound up with the activation of the arousal system by the sign (81, pp. 372, 390, 393); while the s_m component comprises distinctive cues such as kinaesthetic cues, sensations of pain, thirst, and so on. Arousal, therefore, is a basic component of the mediational process or meaning, a sensible position in view of the fact that meaning cannot be activated without arousal (58, p. 80).

The second problem of the part played by arousal in the evocation of the meaningful new linkages in metaphor can be solved by following Osgood's mediational model of problem solving (80, p. 631) in which the sign is a verbal label in the form of a noun, the meaning is an adjective, and the correlative function is a verb. Both adjectives and verbs have been associated with the signs in the past; each noun, for example, has an array of associated properties in the form of adjectives, many of which have become habitual through differential reinforcement, and each property has an array of differentially reinforced functions. This habitual usage, as Osgood (80, pp. 631-632) indicates, implies a correlation between properties and functions; a subject perceiving a pencil as "wooden" would tend to choose "burning" as a potential function.

As a result of conditioning, particularly Razran's semantic conditioning of a response to meaning (88, p. 108), each verbal cue can elicit a range of meanings with certain preferred or habitual meanings for each context, and a great deal of metaphor potential will be stored up within the organism. A state of arousal will activate not merely the preferred meanings of words into ideation, but all the meanings and metaphor potential—this is Staehlin's Der Gefuhlswert der Worte (101, p. 316). Indeed, Smith and Raygor (98, p. 324) have discovered that relatively roused and anxious individuals tend to make less common word-association responses after prolonged visual exposure of the stimulus word than under a control procedure involving brief exposure, whereas relatively stable individuals do not show such an effect. Further, Smith and Raygor (98, p. 325) attribute such increased uncommonness of response after prolonged exposure to "satiation," which they describe in terms similar to those used above about metaphor potential.

> . . . a hierarchy of response potential may exist. With continuous exposure to a stimulus word, each response in order will tend to be aroused and then to become refractory. In time, distantly related responses will occur.

Baker has made the related discovery that the more often a word appears in speech the more meanings it possesses because, to avoid the arousal associated with its monotonous repetition, people develop new meanings for the "arousal jag" of variety (16, p. 188). More concretely, both Kaplan (66) and Mawardi (75) discovered that instructions encouraging subjects to adopt a more feeling approach to experience evokes metaphors based on unusual associations. Kaplan (66, p. 22), for example, found that, in a poetic context, the properties of "brilliant" and "cold" were regarded as identical in response to "stone"; and "velvet" was connected with "dark, passionate, feminine regality."

No further advance can be made until consideration has been given to the dimensions of metaphor preference because there appears to be some distance between the symbolism or, at least, the functional symbolism noted by Bruner and the less elaborate and more specifically linguistic metaphors found in Osgood. A tentative suggestion is that there is a general factor of metaphor preference, certain sorts of individuals preferring all metaphorical products generally (symbolism, personification, and so on) to nonmetaphorical products (technical language and dead metaphors). A second suggestion is that within this general factor there are two dimensions of metaphor preference, active and passive metaphors, which are roughly manifested in the form of verbs and nouns respectively. Santanyana (91, p. 169) has declared for the psychological relevance of such grammatical categories and Brooke-Rose (18) contends that the verb has a direct and specific meaning and is designed vividly to express certain feeling states and experiences, a point supported by Bentham (79, p. 70), whereas noun metaphors are conceptual and abstract, full of complex attributes and meanings (18, p. 209) and are designed to express subtle states sliding into symbolism easily (3, 72, p. 145).

This distinction between verb and noun metaphor resembles Carroll's finding (32, p. 184) that, in a TAT protocol, an active verb associated with a main noun facilitates the placing of the statement in the need category, while a passive verb associated with a main noun facilitates the placing of the statement in a press category. It also resembles Kantor's distinction (65, p. 153) between language as "superlatively active behavior" and language as symbols, "the dead fruits of speech" (65, p. 155); Jakobson's distinction (62) between the use of the structural forms of connected speech and the use of single words to symbolize concepts; and Wells' contrast (114, p. 217) of nominal and verbal styles, advocates of the former considering language as action and advocates of the latter considering it as a state characterized by a static impersonality (114, p. 217). A typically impassive culture like the Japanese (Gorer, 53), for example, has a language with many formal verbs that are syntactically nouns, true action verbs appearing only in Indo-European languages (114, pp. 218-220).

Applying this distinction to Osgood's and Bruner's work, it can be speculated that Osgood is dealing with verb and movement metaphors, whereas Bruner is dealing with noun and static metaphors. Osgood (80, p. 398) accepts the possibility that meaning has both cortical and somatic components and considers, admittedly without specifying any occasions when this will occur, that the cortical component may constitute the entire meaningful response, as it largely does with Bruner. If this be so, then it becomes feasible to speculate that noun metaphor and symbolism are a product of a "set" to handle input cortically and to dampen the arousal component of the somatic aspect of meaning by corticireticular inhibition. On the other hand, the production of the verb metaphor may be related specifically to Osgood's contribution, the s_m component of the mediational process, the distinctive internal response-produced cues that give direction to behavior and which may very well elicit an unusual verb metaphor to describe these organic repercussions of the meanings. For example, thermal cues might also be responsible for the slang exhortation, "Go cool your engine." Kinaesthetic cues may have provoked "We strut to our confusion" (18, p. 221). And these specific cue effects as a group might constitute Osgood's "activity" dimension of meaning. The clearest literary examples of these distinctive cues are Housman's references to the "vibration" and "strong tremor of unreasonable excitement" set up by poetry (60, p. 193).

This applied congruence of Bruner's and Osgood's ideas looks likely and is supported unwittingly by the recent cognitive theorizing of Harvey, Hunt, and Schroder (55), who argue that the relationship between two objects is not directly between the objects but ". . . stems from and is mediated through their mutual dependence on a common interval referent that links these objects in some dimension, rendering them as similar or dissimilar" (55, p. 12). This dimension is clearly Osgood's mediational processes or Bruner's common structure or "metaphoric idea." Objection might be lodged to these parallels on the grounds that Wallach (110, p. 105) prefers to regard meanings as the placing of input in an appropriate category and Osgood's common response an associated trivial matter, while Staats and Staats (99, 100) demonstrated that both connotational and denotational meaning involve a measurable response conditioned to a verbal sign. The way out of this impasse, as has been noted before, is to accept Osgood's point that the meaningful response can be partly and even entirely cortical, with Osgood stressing the overt and covert behavioral responses. This interpretation can be sustained in two ways: first, it is consonant with the fact that the findings of Staats and Staats are based on G.S.R. measures, and Berlyne (16, p. 49) has pointed out that the amplitude of the G.S.R. is a reasonably good measure of arousal; in the second place, Osgood's evaluative dimension of meaning has the correlate (in Bruner's theorizing) of "perceptual recklessness," in which the roused individual, driven to evaluate input quickly, may (when nonplussed) be forced to resort to broadening either the acceptance limits of input (23, p. 145) or of category specifications, so that a variety of somewhat discrepant inputs can come to have the same meaning. Reliance on these wide, highly accessible categories enables the individual to develop premature responses that interfere with the correct perception of low-probability contingencies. For example, Harvey, Hunt, and Schroder (16, pp. 213-214) point to the fact that authoritarians possess simple, wide, concrete, and evaluative categories (43, pp. 165-166).

Clearly Bruner is not so different from Osgood as the stereotyped labels applied to them might suggest.

E. Personality Correlates

The hypothesized personality correlates of metaphor are logically implied in what has gone before. The correlate of the general factor of metaphor preference is susceptibility to supranormal arousal or to the arousal function of stimuli, a factor similar to Burt's general factor of "emotionality" (28, 29). This psychological function attributed to metaphor makes sense in the light of claims by artists and by critics on the creative handling of input. Langer (72), Amberg (4), and Gombrich (52) indicate that input is potentially ambiguous to roused people like artists distinterested in using conventional categories, for whom the metaphor generally provides an opposite medium for expressing the new assortments of input that they experience.

The two dimensions of metaphor preference are likely to be associated with two defensive reactions to arousal-increase. One defensive reaction, as Luria has indicated (74, p. 19), is to let the arousal flow immediately over into motor discharge, or even to engage in motor activity to prevent the activation of arousal. An individual reacting in this way must be "motivationally open to stimuli" (111, p. 170; 23, p. 131). This is one of Barron's personality clusters (14, p. 236), and Wallach (111, p. 170) regards it as an extraverted reaction. It is clearly correlated with verb metaphor. A second defensive reaction to arousal-increase is by inhibiting arousal cortically (16, p. 181; 74, p. 193; 14, p. 737), responding to the cue rather than to the arousal function of stimuli. Luria (74, pp. 419-423) contends that the inhibition of "excitation" can be carried out only by cutting off the roused state or impulse from its associated diffuse and primitive motor expression and by coupling it with an intervening link—very often in the form of a high cultural product—that regulates the "excitation" through its associated controlled motor activity (74, p. 423). As a demonstration of this point, Luria reports the reactions of a hysterical patient to three posthypnotic suggestions that advocated an increasingly symbolic expression of her difficulties. The first exhorted her to experience her difficulties, but not to relate them; the result was "diffuse excitation" and a "motor storm" (74, p. 425). The second suggestion exhorted the patient to express her experience with paper and pencil. The result was a "motor storm" on paper (74, p. 425). The third suggestion exhorted the patient to express her experiences in symbolic forms that would describe her state, but not be intelligble to everyone at once; the result was a symbolic drawing without overt motor disturbance. Luria (74, p. 426) concludes that the subject had controlled her behavior by diverting affect on to the conditioned symbols.

The personality dimensions of metaphor, accordingly, are similar to those of Eysenck (43) and to those used by Kassebaum, Couch, and Slater (69), and to those of Couch and Keniston (37); the general factor of metaphor preference is associated with the neuroticism or anxiety (15) or arousal dimension; verb metaphor is associated with Kassebaum, Couch, and Slater's first "fusion factor" of impulsive extraversion, and noun metaphor is associated with their second "fusion factor" of anxious introversion. [See Wallach and Greenberg (112)].

This psychological model for metaphor has the usual advantage of being open to experimental test and the disadvantage of being susceptible to the recent stricture of Koch (70, p. 631) who criticized the general position, which is certainly implied in this research, that a man operates to reach some incentive by correcting some deficiency or deprivation. Koch (70, pp. 634-635) believes that the incentives are certain patterns of "value-determining properties" that are defined tentatively as "specific relational attributes of experience" (70, p. 636). To describe these experiences according to Koch (79, p. 630):

> We will have to arrive at a highly differentiated set of metaphors, each of which is isomorphic with a significant relational aspect of experiential process, and learn to use these intersubjectively. . . .

Many writers have used a phrase similar to Koch's "significant relational aspect of experience": Valery (108), Waismann (109), Fletcher (44), with Whalley (121, p. 155) coming closest to it. However, it is difficult to see how this differs from Berlyne's "conceptual congruity" with its arousal-reduction consequences. Indeed, most of the examples of behavior that Koch cites to deride psychological accounts of motivation can be reduced without force to Berlyne's model, which has the added advantage of being free from circular inference.

A second criticism of Koch's concept is that, while creative thinkers do use metaphor as Pederson-Krag (85) and Nash (78) have demonstrated in the case of Freud, nevertheless these same metaphors tend to get out of hand and tend to provoke erroneous predictions—Nash has shown how Freud's "play-within-the-play" metaphor led him astray—and, further, Koch's and Pederson-Krag's argument that private and subtle cognitions can be bodied forth only by metaphor leads to the assumption that the interpretation of these metaphors is the province of a group of cognoscenti "attuned to these subtleties" (85, p. 70). This is the antithesis of the scientific approach that depends upon the public validation of testable conceptions and not on the consistency of private decisions by a coterie (111, p. 61). Examples of this latter approach can be provided in the case of the present model. If metaphorical preference is the product of a roused state, then normal subjects under the influence of hallucinogens will experience synaesthesiae, a finding reported by Trouton and Eysenck (105, p. 680), Guttman (54, pp. 209-210), Downey (39, pp. 471-478), and Ullman (107, p. 287); normal people under conditions of strain will prefer metaphor (19, p. 16), as will disinhibited people (92, p. 433); the association between metaphor and humor will be close (63, pp. 150-151; 50, pp. 30-42) and, if brain damage marks an individual in an extraverted direction (77, p. 552), then brain-damaged patients should show a preference for metaphor, a prediction made plausible by Head (56, Vol. 2, pp. 230, 256-257, 515-516).

Credit must be given to Koch for his determination to enlarge the content of psychological investigation, but this cannot be done by resorting to explanatory concepts that are reducible to simpler and more standard forms.

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ADOLESCENT ATTITUDES TOWARD DEATH*

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A. INTRODUCTION

"I'm scared to death of death"—a student.

To say that the adolescent, on the threshold of independence, lives in an intense present and is concerned primarily with life, love, autonomy, choice of vocation, status, the pressure of peer conformity, and how to get his hands on an automobile is to present the conventional and true picture. To say, on the other hand, that his concept of death permeates everything that he feels, thinks, and does is intended less to challenge present thinking than to illumine a dark dimension of the elephant of adolescence. It is hoped that investigation of this aspect of youthful thinking, heretofore hidden in a blind spot of adult distaste, will help to round out our understanding. The enigma of aberrant behavior as well as the source of the idealism of youth may be found centered exactly where we have not looked.

It cannot be said, as is often declared of children, that adolescents know nothing of death. Their slang is redolent of its imagery:

"This will slay you!"
"I nearly died laughing!"
"Drop dead!"
"I was so embarrassed I could just die!"
"This town is dead on Saturday night!"

It may be argued that these careless phrases do not refer to death as the cessation of life. "Dead," as used in casual conversation, meaning "uneventful" or "extremely" or "out of sight," may be mere simile. Yet the purpose of a simile is to heighten a description by comparing the object or situation under consideration to another, either more familiar or with a stronger affect. Lacking verbal inventiveness, the adolescent reaches easily for the word representing the idea with the greatest amount of familiarity and emotion. "Nothing is happening here" is therefore less vivid than "this place is dead," which describes the lack of activity in a term that carries the emotional content of nothingness to the highest imaginable degree. Such references are com-

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monly greeted with laughter, another indication that they have touched upon a severely repressed source of anxiety.

One of the very few to attempt an assessment of this highly charged subject, Kastenbaum (4) poses the question: "Is the average adolescent's attitude toward death part of the structuring principle dominant at this point of his life, or does it belong to a second, discrete, psychic organization?" He concluded—on the basis of paper-and-pencil reactions of 260 high-school students to the words *death, good, real, life, bright,* and *myself*—that the second hypothesis was more tenable. Death has been set aside as a separate conceptual unit.

This conclusion would seem to be born out by the hushed and awed tones with which adolescents ordinarily discuss the subject with adults in marked contrast to their usual coerced or extraneously motivated attention to academic subjects, and in still greater contrast to their gasping or giggling at horror films which, suitably diluted with the oral satisfaction of popcorn, fill their prepetting hours on the Saturday-night date.

What Kastenbaum does not make entirely clear is his definition of "discrete psychic organization." Of his six key words, five have a pleasant emotional tone and only one has a negative tone. His students tended not to include death in their present concerns, but rather to put as much time as possible between themselves and consideration of their ultimate future. Yet in his introduction he speaks of "the significance of death attitudes as one aspect of a person's general psychological functioning." What would seem to be involved is a difference between the structurings of acceptance and rejection. Acccording to the pleasure principle, the adolescent strives toward *good, real, life, bright,* and *myself,* but away from *death,* which is unpleasant. The adolescent, in other words, exhibits nothing that could be identified as a "death wish."

Frieda Fromm-Reichmann (1) finds herself "in agreement with Sullivan, Fromm and other dynamic psychiatrists who do not find . . . any evidence of the original existence of self-destructive tendencies of a death instinct, as a given ubiquitous phenomenon." Kastenbaum's evidence would lend weight to this view.

Accepting the judgment of the dynamic psychiatrists as biologically sound, we can go on to a consideration of the possibility of measuring the depth and the variety of adolescent ways of rejecting the idea of death.

Marie Nagy (7) in a study of the attitudes of young children toward death, finds three distinct stages through which the child matures:

> The first stage, which characterizes children between the ages of three and five years, highlights the denial of death as a regular and final process. . . . Death is envisioned as being temporary. Indeed the distinction is made between the degrees of death. [Between 5 and 9] death is personified. . . . Only those die whom the death-man carries off.

When the child reaches 9 or 10, Nagy found, "death is recognized as a process which takes place in all of us. By then children know that death is inevitable." As one result of her study, Nagy finds the child's attitude to be the antithesis of discrete. She says: "Indeed the child's conception of death reflects in a large measure his general picture of the world."

We propose to continue this maturational study by extending the inquiry through adolescence. Are there steps beyond the discovery of inevitability? How does the adolescent handle this knowledge? Is his picture of the world affected by his attitude? Are there observable differences between those whose mental age levels off at early adolescence and those who continue to grow?

The commonest measuring device of an integrated and smoothly functioning personality during the school years is the achievement test. Results are known to be affected by native intelligence and environmental opportunities, although a nagging suspicion plagues us that an emotional factor may be as important as either of these. Yet no satisfactory measurement of anxiety level is available.

Fromm-Reichmann (1) declares:

> There are various ways in which people may try to counteract the anxiety and the narcissistic hurt inflicted on them when they are faced with the necessity of accepting the reality of death. The powerfulness of these defenses is a measuring rod for the intensity of the anxiety which people try to fight off with them.

We cannot agree that the size of the guns measures the strength of the enemy, especially one that always wins in the end. Perhaps the strength of the defense or its effectiveness may measure the degree of peace and civilization permitted within the stockade. However, we will agree that measurement should be possible. Will we find that the more successful adolescents have erected adequate and mature defenses and the less adequate are still wallowing in immature and inadequate solutions?

Our hypothesis is that death, while seldom the topic of the adolescent's preferred, deliberate consideration, nevertheless hovers on the horizon of his peripheral attention and colors his life style to such an extent that significant and graduated differences will be found to correlate with academic success.

If this be true, it may suggest new ways of correcting poor achievement and delinquency. To intelligence and opportunity will need to be added the third dimension of emotional maturity as measured by the death anxiety and the kinds of defenses raised against it.

B. Method of Investigation

Because structured questionnaires often reveal (by their very structuring) the expected result, and because subjective sources of criteria seldom reflect other than the preference of the originator, it was deemed more expedient in this pilot study to use the unstructured approach. Rather than harvest predictable grains of truth from well-planted seed, we have plucked the unpredictable weeds and wild flowers of an uncultivated wilderness.

The questions: "What comes to your mind when you think of death?" "What comes to your mind when you think of love?"

The second question was added to reduce the traumatic effect of the first, because the original group to whom the assignment was given sat in stunned silence, pens poised but apparently immobilized. Permission to attempt to write on either topic first, each to cover one side of a sheet of foolscap, seemed to free most of the students of the initial shock.

"Must we sign our names?" Again permission was given to withhold identification if that were preferred, but it was urged that people should be willing to sign their names to their opinions. They were assured that there were no right or wrong answers, that nothing that they wrote would be held against them, that their grades would not be affected, and that no one in the school but the examiner would read the papers. It was frankly explained that this was a research project. With these assurances and the questions repeated, there remained half an hour in which to write. Only three subjects blocked so completely that they produced a blank or only a few scratched over words saying nothing. All but nineteen signed their names.

The subjects were 172 senior high-school students, members of classes in "healthy family living," all taught by the same instructor with whom they were familiar, and many of whom were or became counselees. They had in common an age range from 17 to 19, attendance at a large, integrated city public high school and they were all girls. (A similar study of boys is a necessary next step.) They were dissimilar in that their scores on the American Council of Education test ranged from 1 to the 99+ percentile. They represented Orthodox and Roman Catholic, Protestant (liberal and fundamental), Jewish, Mohammedan, and Buddhist religious backgrounds, and three major racial groups: Caucasian, Mongolian, and Negro as well as admixtures of these. Economically, the homes from which they came included a few moderately wealthy, some professional, many skilled and unskilled working parents, and some that were served by various relief agencies. About half planned to go to college. A few had been married and two had had illegitimate children. Some had had other difficulties, but counseling had kept them in school. In a sense, all were successful high-school students in that they remained after the permissible leaving age, had reached their senior year in an accelerated, regular, or remedial track and planned to graduate.

No statements about the average adolescent can be made on the basis of these findings because these were not average students. They were, however, more representative of the full range of diversity of American youth than a similar number of suburban or small town students self-segregated by ethnic similarity. The wide range of opinions and attitudes that they expressed cover a broad spectrum partly because they were cosmopolitan and partly, perhaps, because thinking for one's self had been encouraged in prior discussions of personal, family, and racial relationships. It was interesting to note that the essays on love (with some exceptions) reflected a maturity gained through such open-ended discussions. Most of them wrote of romantic, filial, and altruistic love for humanity. The essays on death showed no such learned similarity.

C. Assessment

In reading the essays, it became apparent that it would not be a simple matter to place them on a continuum from inadequate to mature. Some subjects had had recent deaths in the family and the circumstances were reported. Others reached back in memory to the last death or funeral in their experience, while still others hinted obliquely at personal involvements. Some attempted philosophic discussions with quotations from the Bible, from Shakespeare, or from the poetry of John Donne. Only one mentioned the statistics of the National Safety Council and only one thought to be grateful to the "heroes who died for our country."

Originally it had been planned that several judges would rate the essays on the basis of maturity and the resulting serial order would be correlated with the percentile rank of each student on the American Council of Education test. This proved not feasible because, not only could the judges not agree, they could not even decide. Thus the first attempt to sort the papers on the basis of a single maturity score was abandoned.

Yet, there were obvious differences. The top ten per cent (in terms of scholarship) wrote papers superior in quality as well as in grammar and spelling. The lowest ten per cent (in scholarship) were inferior in both respects. The compositions of the two groups contrasted so markedly that we could but differ with Kastenbaum's ambiguous statement: "There are no differences in general intellectual ability suggesting that the way young people integrate the meaning of death into their lives involves something other than the *IQ* alone" (4).

The better students expressed acceptance of the inevitable, a determination to live a full life and considerations of ethical conduct:

> Instead of dreading or hastening death people should do their best in life so that they can pass something good on to the generation that springs up after their death (L. W.).
>
> I do volunteer work with children of fatal diseases (leukemia). I have come to know death and accept it without fear. Death of some of these children is almost a welcome sight as many of them have been in pain for almost a year. Then again, death in such instances makes one think of the day when medical research will end the great suffering of these children (E. Q.).
>
> I am not afraid of death and yet I do not want to die. I like life too much. I want to live to be quite old. I want to do something in my life I can be proud of and work very hard to the last years of my life (J. H.).
>
> As I get older I realize how fast time flies and that I ought to fill it up and do as much as possible so as not to waste it (R. K.).
>
> . . . when a person dies they are completing a cycle of life and that is right (S. L.).
>
> . . . something we have to accept. What we should do is make the best of our lives before it is too late (D. D.).
>
> Fear of the unknown is a common human reaction. It is readily seen in race prejudice and in many other forms (K. P.).

In contrast, the last ten per cent, those who were barely making the grade, found it more difficult to express their thoughts. Not all of them included the primitive modes of thought, as in the examples below, but most of them were as inadequate.

> For one reason I am afraid of dead people or things, animals etc. My favorite grandmother and grandfather died and another thing I think is I wonder how they feel or do know anything? Is it cold down there and do they have enough to eat?

Because these students may have changed their minds they will not be identified.

> My father passed away when I was five years old. It was a sad day for everyone. Everyone agreeing about what color the casket should be according to the clothing wore.
>
> I have experence many deats in my life and after it is all over I come back to normal as if nothing had happened but if it were my mother or father I wonder if I really could be as happy as they certainly would be missed by me.
>
> When I hear the word dealth [sic] I think of my family especially if anyone is sick. But if the one who died is a gangster or something it wouldn't bother me because I would think he should have been dead anyway.
>
> When someone speaks the word to me I start thinking of ghosts or when someone die I think they will come back to haunt you. Sometimes I have the vision that when you die you don't really die, you just be in a deep sleep and there is no way to tell people that you are not dead. I have a feeling that when you are buried or your body burned to ashes you don't really be dead, but after you are buried you probably die then.
>
> This is a silly thing to write about. I don't think anything. Except this one thing I'll tell you, you better shoot first.

Between the two extremes, there was a bewildering variety of other material neither predominantly thoughtful nor excessively traumatized. Without any attempt to order these into a series, we found references to sadness, remorse, loneliness, suicide, peace, beauty, uncertainty, life after death, accidents, transmigration, spirit talking, insurance policies, sleep, manner and time of death, mystery, smells (decay, flowers, and coffee) as well as humor. ("I rather fancy myself dressed up a ghost and scaring the heck out of everybody.")

There were admissions of fear and denials. To describe sensations, they used almost every adjective from agonizing to yearning. Surely no continuum could encompass all this.

An additional difficulty lay in the fact that the 153 students (after the 19 anonymous ones were eliminated) did not form a normal probability curve in relation to achievement. Both ends of the curve were heavily overpopulated and the middle lacked the usual bulge. Each of the 10 deciles should have included an approximately equal number of students, but we found the distribution of cases to run 46, 21, 10, 15, 9, 7, 9, 6, 7, 24, from low to high.

For convenience, a rough division into four groups was agreed upon. See Table 1.

Each of the papers was digested into major and minor ideas, references, and word use. The first sorting resulted in 117 categories, but unwieldiness forced a reduction to these: sorrow, fear, tone, loss, superstitions, immortality, inevitability, release, euphemisms, religion, enjoyment of life, and "do good." The miscellaneous category was necessarily a problem. Some of these categories

TABLE 1
DISTRIBUTION OF CASES BY SCORES ON A.C.E. TEST

Group*	Classification	Percentile ranks	Number of cases
1	very high	90 to 99+	24
2	above average	50 to 89	29
3	below average	10 to 49	54
4	very low	.001 to 9	46

* The rough division of our sample into four groups was agreed upon because of the double skew toward the extremes of the scale and the lack of sufficient cases in the middle percentiles.

will prove to be important, others can only raise questions that are unanswerable. Sorrow and sadness, for example, were evenly distributed throughout the sample, mentioned by slightly less than 50 per cent of the subjects. It had little differentiating value.

"Fear" and "afraid" were treated as synonyms. Together, they appeared more often than any other category, although they were handled in many different ways. The question arose: Shall these reactions be treated as free-association material or as the product of considered decisions and accurate reporting? If they are to be interpreted clinically we can, in fact must, ignore all negatives. Thus "I am afraid of dying." "Most people are afraid." "People should not fear." and "I do not fear." may be equated. The quality of fear being mentioned at all indicates its presence. Projecting it onto others or repressing it by denial gives it a different quality in the psychic structure, but indicates nevertheless that it is a factor therein.

On the assumption that the mention of fear is significant regardless of the manner in which it is used, we find the curious maldistribution indicated in Table 2. Awareness of fear appears to increase as ability lessens, until we reach the retarded where less than a fourth speak of fear in any connection. This result was not expected. An even distribution or a steady rise from bright to dull or vice versa might have been easier to interpret.

TABLE 2
USE OF WORDS "FEAR" AND "AFRAID"*

Group	Classification	Mention of fear (per cent)
1	very high	46
2	above average	51
3	below average	63
4	very low	24

* Use of the words "fear" and "afraid," in all contexts, whether admitted, denied, or projected, rises from high to low except that there is a sudden marked drop in the use of the words in the group below the tenth percentile on the A.C.E. test.

The quality of the reference to fear also presents a mixed picture, but two important distinctions stand out. See Table 3.

TABLE 3
CONTEXT OF REFERENCES TO FEAR*

Group	Per cent who: Admit fear	Deny fear	Project fear
1	21	17	17
2	31	7	24
3	43	11	17
4	11	0	13

* Appearance of the words "fear" and "afraid" were accepted as they stood, for this categorizing. Denial, even though accompanied by a projective statement that nullified it, was included as denial. A statement, such as "I used to be afraid when I was little but now I am not." was included in both admission and denial. No distinction was made between denials that may have represented affect and those that were obviously whistling in the dark.

The admission of fear at the thought of death or dying follows the same trend as mentioning it at all—a steady rise from high to low with a sudden drop for the very lowest. Denial is rare in any group, but significantly none of the least successful group write, "I do not fear." Projection does not seem to differ very much from one group to another perhaps because of the tendency of the judges to use it as a catchall category to include admonitions ("You should not fear."), circumstances ("When it hits their own families . . ."), quotations ("The preacher said . . ."), as well as direct projection ("Most people fear . . .").

Fear has many near synonyms in English, especially in the subdialect common to youth. The next step was to count the number of cases in which, from the use of related words and phrases fear could be assumed. Naturally, the choice of words reflected the size of the vocabulary, but it told even more in regard to the underlying feeling tone.

Group 1 was adult: traumatic, morbid, tragic ordeal, strange empty void, overwhelming dread, dry-eyed hysterics.

Group 2 wrote of nothingness, dark agony, eerie feeling, crawly sensation, weak inside, goose pimples, chill in the air, all balled up inside.

Group 3 reported nervous and jumpy, mind goes blank, worst of all sensations, horrible, gruesome, draws strength out of me, awful, sick inside.

Group 4 used shock, scary, sickening smell, go mentally unbalanced thinking about it, hurting inside, decay, destruction, all tore up inside, and like a cracked record.

Without pressing the justification of including all these and similar terms in one category, we found that they produced the same maldistribution. Including the direct words *fear* and *afraid,* fearful feelings rose from 75 per cent of Group 1 to 83 per cent and 85 per cent of Groups 2 and 3, but dropped off sharply to 61 per cent for Group 4.

No satisfactory explanation presented itself immediately. Did the poorest achievers fail to discuss fearful sensations because they were afraid of fear? Significantly, among the very lowest, those who achieved a percentile rank of less than 1.00, only 38 per cent mentioned fearful feelings and in the eight who did not, five of the papers were very brief. A few short and often scratched-over sentences were all they could manage, yet they wrote volubly of love.

What then did they write about? One very large category was "loss." ("When I hear of someone dying I think what if it was someone in my family next?")

Fear of the loss or disappearance of the parent has been used repeatedly to describe the "real" fear of the very young child (8). Separation anxiety is considered more threatening than death per se, which the child "does not understand." In truth, the child cannot speak of his own demise (3) yet his reflexes work well enough to scream for life-sustaining food. In the range between reflexes and intellectual understanding is a broad band of operating procedures sometimes called instincts, but in any case a complex of coordinated reflexes and feeling preferences for whatever is life-preserving (5). In this area, the loss of the parent is threatening *because* it presages danger to the life of the dependent child whether he "knows" it or not. The loss of other members of the family is similarly a loss of a part of one's identifying group and is a psychological threat rather than an actual threat to the self. Traumatic as it may be, it can be contemplated with less "blank-out" than can personal nonexistence.

Separation anxiety may therefore be considered characteristic of the immature when it comprises the total or major reaction to the thought of death. In our sample, the number of subjects who expressed fear or dismay at the thought of loss clearly corroborates this. In Group 1, the single case was a girl for whom the threatened loss was an immediate probability and who was therefore under a regressive stress. In the other three groups, there was a sharp rise from 10 to 22 to 39 per cent. This, too, may represent regressive stress because actual loss is more common among the deprived students than among the successful. Fully one fourth of the students in Group 1 mentioned that no one in their families had died, while those who wrote that they had known many deaths were bunched at the lower end of the scale. The mortality rate is greater among the lower socioeconomic classes. The effect of this may be more pervasive than poor housing.

Distaste for dead bodies, mentions of ghosts, spirit communications, haunts, of the smell of decay, and of funeral flowers, and questions as to how the dead "feel" were all confined to the two lower groups. The use of euphemisms ("passed," "deceased," "cross over," and the like) showed a strong trend in that they were not used by the top tenth and became progressively more frequent toward the lower end. Similarly, the interposition of the "word" between the self and the thought was characteristic of the below average ("I hate the sound of the word."). So also was the comparison of death to sleep or to "final slumber." The two students who thought first of safety and the one who denied the worth of modern medicine were among the miscellaneous. ("Do I dare drive a car?" "Mothers should watch their children better as it seems most of them die by accident." and "Some people feel they can keep from dying by having medical treatments but it is impossible to do so."). By the standards of the dominant culture, these are excessively fearful.

Thoughts of violence, accidents, murder, and sudden death are of special interest because they represent remnants of the thinking of children between 5 and 9. In this second stage, Nagy (7) found that death is recognized as happening, but only occasionally. Her children spoke of the "boogie man." The American child of the 1960s hears less of direct threats of this kind. His attitude is formed more commonly by the television set where the threat of sudden death is projected onto the "bad guy." The modern monitoring of the child's behavior by the death threat accomplishes the same purpose. It keeps him quiet. The secondary effects may be less traumatic in that projected material is less threatening than personalized immediacy.

In any case, the playtime of the 5-to-9-year-old is consumed with acting out the drama of death. The mock warfare of "cowboys and Indians" or "cops and robbers" enables the child to attack and kill freely and, in the view of most parents, acceptably. They supply the toy guns, and who is brave enough to impugn their motives by depth analysis? This second stage precedes and merges into the period of the recognition of inevitability. For all but the deprived, the manipulation of death by toy guns begins to lose its appeal. The boy is ready to become interested in the girls who have been playing serenely with dolls all that time.

Feminine acting-out has centered about birth and nurture as the answer to the death threat. Remnants of this appeared as a belief in direct substitution. ("Every time someone dies it seems a baby is born to take his place.")

Statements about violence, however, were found in all groups, but as an exclusive emphasis only in the lowest. In Group 1 it appeared in a form recognizably once removed. ("You read about accidents all the time in the papers . . ."). In the other groups it became progressively more common and more personal.

This study was made of young women rather than males and there was only one expression of determination to kill in self-defense. ("This one thing I'll tell you, you better shoot first.") It was written by an aggressive girl of pronounced masculine tastes who was known as a "bull dagger." More reactions of this type could be predicted among unsuccessful males. An interesting hypothesis for such a study might start with the baffling mystery about the juvenile killer—the calmness and easy sleep that follows the murderous episode. Is this possible because, in some primitive recess of his mind, Death remains personified, killing has destroyed it, and terror is temporarily at bay? Is wanton murder an acting-out of the death anxiety, a terror-inspired gesture of defiance?

Less concrete examples of personification occurred once in each of our groups. They demonstrate very neatly the growth of civilizing autonomy.

> Group 4: "Will death call your name or what?"
>
> Group 3: "I am Death's worst enemy."
>
> Group 2: "Death lurks in the shadows waiting for a chance to strike."
>
> Group 1: "'Death be not proud, though some have called thee mighty and dreadful.'
>
> "Death be not proud, proud in the sense of being the last achievement in life. Be not proud as the dominant concern of life. Be proud only so that people lose their dread of thee."

The first of these implies an actual belief in a voice and a sense of helplessness and the need for unquestioned obedience. Just as when a parent called, the individual has no autonomy that could do anything but obey. The second is less helpless, less embodied, but the only ability open is to fight back. The third is still less embodied. Death merely lurks. With reasonable caution, one is not helpless. The last was written by the valedictorian of the class, the daughter of a professor of ethics at a major university. Here the personification is from a quotation used to introduce the topic, a text so to speak. The body of her composition urged concern for the welfare of future generations. Such maturity is rare, even among adults.

Categories found most often among the higher groups and seldom or not at all in the lower included inevitability, release, enjoyment of life, and ethical considerations.

Inevitability was implicit in most of the papers, but it was stated explicitly with varying degrees of skill and acceptance. In Group 4, 21 per cent said typically, "You gotta go sometime." In Group 3, 35 per cent recognized that "Everybody dies sooner or later." More than half, 51 per cent of Group 2 stated in effect, "Life ends for all." For 87 per cent of the brightest group, it seemed important. "Physiologically death marks the close of the life of the individual."

Peace and release from suffering was generalized by some and by others limited to those who were ill of an incurable and painful disease, such as cancer. Six per cent of the slowest, and close to 25 per cent of each of the other three groups agreed and a few added that "Death from old age isn't so bad." Suicide as release ("When the load becomes too heavy, why don't people just kill themselves and end it all?") was suggested by one, and three others—all in the middle groups—wrote that their study of Hamlet had taught them that the only reason people didn't commit suicide was because they were cowards. The only other mention of suicide was a condemnation of it and of capital punishment. ("I just don't understand and I feel very sorry for the person.")

Genuine enjoyment of life seems to be one of the most effective defenses against the death anxiety. None in Group 4, 11 per cent and 19 per cent of Groups 3 and 2, and a whopping 46 per cent of Group 1 loved life too much to want to think about death. Here, cause and effect are probably circular.

Approximately the same percentages were found for those in whom the brevity of life inspired thoughts of responsibility for others. For most, it was an after thought or a vague reference to "helping others," "live right," "do your best," or "be kind." Only five, and all those in the superior group, made specific reference to future generations.

Religious faith in a future life is, for most peoples of the world, the conforming answer to the death anxiety. It is surely more civilized and mature than the simple denial of primitives who included food, raiment, and slaves in the tombs of kings to keep the latter contented. It is an improvement over head hunting and wanton war that seeks to destroy the boogieman of fear. And yet, for civilized man it is a faith hard to sustain. Pervasive doubt may result in the "fear and trembling" so poignantly described by Kierkegaard. Or it may be sloughed off easily and without regret by liberal intellectuals dedicated to good works and to the improvement of the present world. Adolescence is the period in which this question comes to the fore. To the three maturational stages of the death anxiety: (*a*) denial, (*b*) fighting off, and (*c*) accepting the inevitable, we are now ready to add the next, (*d*) finding a suitable sublimation. See Table 4.

TABLE 4

RELIGIOUS AND OTHER SUBLIMATIONS OF THE DEATH ANXIETY*

Group	Per cent who: referred to religion or sublimations	believe in life after death	questioned, "mystery" or doubt	disbelieve	had other sublimations
1	79%	16%	41%	12%	33%
2	74%	33%	33%	8%	11%
3	60%	28%	24%	9%	none
4	39%	23%	9%	2%	none

* Religious questions in the larger sense concern more of the intelligent than the slow. Fewer of the bright expressed convinced belief in a life after death and more of them have open, questioning minds than the dull. Outright disbelief is rarely expressed in any group and only the above average and very bright had found other sublimations, such as "You live on in the memory of your friends." "We are all a part of the chain of life." or "The world goes on." Per cents do not add up to 100 because many subjects made statements that included two or more categories.

Our group of adolescent girls were not asked to discuss their religious beliefs. Yet the topic of death inspired more than half of them to write of religion, their belief, or disbelief in an afterlife or their questions as to the mystery of immortality.

Before concluding this study, some mention must be made of what can be little more than a hunch at the present time. Kastenbaum (4) seems to have come upon it in what he describes as the "boomerang effect." He writes:

> It is as though the adolescent were seeking to throw away his past but that this most unwelcome subjective entity acts as a boomerang which meets him in his conception of the remote future.

Without positing entities of any kind, we found a curious tendency of some students to describe death in terms of what may have been most threatening in infancy. It was not possible to study all these lives longitudinally, but those that became known offered some amazing examples.

The unusual term "nauseating" was the first thought of only one of our subjects. She was a beautiful, intelligent girl who in her own terms was a "miracle." Her life had begun as a premature baby with pyloric stenosis. Her mother had told her that she had spent the first six months of her life vomiting.

"Death is a harsh word." was the opening sentence written by another girl who later described her mother as one who "never had a good word for anyone." In describing her family life she said, "All she [i.e., her mother] ever does is yell at the kids (younger siblings), usually screaming."

One of the most interesting of these examples was written by a shy incompetent whose percentile rank was .006. Later, in a counseling session, she said that she could not remember anything of her childhood. She knew that she had left Mississippi when she was three years old, that her parents were dead, and that the "Auntie" with whom she lived was not a blood relative. She had written:

> When I think of the word death; My eyes see people crying, houses are old and their decaying; everyone is very sad and their is no happiness in the world. To me every living flower, grass, trees, crops has just turned their back and died.
>
> The people have long faces, sad eyes, their clothing becomes old and thattered, their shoes have many holes in them because their woren out. The earth looks cold and wreary with no happiness what so ever. There is no gayiety that the world use to have. In a way you want to pack you bags and leave. Then after you leave your country, and land somewhere else its just the same. But it still is worse, and it keeps getting worse wherever you go.

The temptation to interpret this as a "forgotten" childhood scene is very great especially since there are no crops in the large city in which she has spent all of the life that she can remember. Or the memory may have been inspired by stories heard from adults. If it merely reflects her general picture of her present world, this is important to know. In any case, a mind that is preoccupied with sadness and decay has not been able to profit from instruction, however expert, in the rules of spelling and punctuation.

D. CONCLUSIONS

Adolescence is a time of greater decision than has heretofore been given psychological attention. To the crucial questions of sexual adjustment and independence must be added the problems that have been labelled "identity" or "purpose," but which are fundamentally the need to find a satisfactory sublimation for the death anxiety either in religion or other altruistic choices.

Observable differences in the thoughts of adolescence on the subject of death range from very childish to very mature with many distinctive features not readily assessable without knowledge of special circumstances in the lives of the individual. In general, statements made and vocabulary used in spontaneous essays tend to be associated in degree of maturity with academic achievement.

Poor achievement is associated with greater fear, often so pervasive that it can be communicated only indirectly. Typical also are separation anxiety, remnants of beliefs in ghosts, spirits, haunts, mention of smells, corpses, accidents, disease, and violence. The greater use of euphemisms and similes, such as "sleep" and "journey," questions as to how the dead "feel," and degrees of deadness are stigmata of slow minds.

High achievement is associated with a greater sophistication in acknowledging inevitability. More of the effective minds declare that they enjoy life and find satisfaction in helping others, in planning a useful life, and in thoughts of betterment of mankind.

Which is the cart and which the horse cannot be demonstrated, but it seems worthwhile to consider that ineffectiveness may be the result as well as the cause of inadequate defenses against death anxiety (6). The innate *IQ*, which cannot be measured, may pose a less crucial problem than the freeing of all human minds from irrational fears that hamper full functioning. Perhaps the mentally retarded have hindered minds rather than defective ones. Emotionally disturbed adolescents need, perhaps, less "adjustment" and more help in making decisions that aim toward the successful mastery of the human dilemma.

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PIAGET'S PROBLEM OF CONSERVATION OF DISCONTINUOUS QUANTITIES: A TEACHING EXPERIENCE*

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A. INTRODUCTION

In the last few years an increasing number of psychologists have begun to appreciate the contributions of Jean Piaget to our understanding of concept formation. In particular, a number of studies have been appearing in the literature concerning Piaget's approach to the development of the concept of conservation of quantity in children (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14). As used by Piaget, understanding of the principle of conservation involves separation of the number or quantity aspect of an aggregate from the spatial arrangement of the items or the material in the aggregate. It is Piaget's contention that the knowledge of conservation is a prerequisite for the understanding of concepts of number and depends upon acquisition of the principle of one-one correspondence.

A number of studies have been replications of Piaget's experiments (2, 4, 5, 6). Except for a study by Estes (5), the findings of the investigators have generally supported Piaget's empirical observations if not always accepting his interpretations (2, 4, 6). Other studies have attempted to incorporate Piaget's findings into a general theory of cognitive development (10, 11), and still others have made some attempt to assess the learning processes involved in the child's acquisition of the conservation principle (5, 7, 10, 12, 13). Notably, in the latter two categories, results from an experiment of Smedslund (11) on the analogous problem of conservation of weight indicated that the concept of conservation of weight may be acquired as a function of external reinforcement, in this case direct observations that objects do not change weight during deformation. Another experiment by Wohlwill (12), on the acquisition of the conservation of number, compared reinforcement by adding and subtracting with direct external reinforcement of conservation. The results suggested the superiority of the group trained on addition and subtraction. In a later study (14), Wohlwill found that, although addition

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and subtraction proved more effective than other methods tested, it had only limited success in inducing understanding of the conservation principle. Using a different approach than Wohlwill, Feigenbaum (6) also had some success in training children to understand the concept of conservation of number. Training consisted of direct verbal reinforcement and of an operation in which a subject performed one-one provoked correspondence with his eyes closed. This latter procedure was in keeping with a current idea in concept formation theory that reduction of irrelevant stimuli decreases task difficulty.

The results of the experiments cited are not restricted to any particular learning theory, nor have they yielded decisive evidence as to the conditions under which the conservation concept is most readily learned. They have been explained both in terms of traditional S-R theory or equilibrium theory as enunciated by Piaget and his co-workers. The explanation offered by the S-R theorists states that success in understanding the conservation principle rests upon accumulation of direct reinforcements of the principle either in everyday life or in the experimental situation. The equilibrium theorist explains acquisition in terms of the reorganization of the mental operations available to the child during a particular age period. Experiences that tend to reorganize the child's mode of thinking, such as exposure to adding and subtracting, or to the distinction between bigger (size) and more (number) are thought to produce transfer to understanding of conservation. Naturally, S-R theorists indicate direct reinforcement to be the method most productive in producing understanding of conservation, and the equilibrium theorists suggest experiences such as those cited above. As yet no experiments have adequately settled the controversy.

B. Purpose

The purposes of this study were (*a*) to test and compare the efficacy of different methods of teaching the principle of correspondence and conservation to children and (*b*) to interpret the results of these methods in order to provide further explanation of the child's acquisition of the conservation concept.

C. Subjects

Subjects for this study were 50 kindergarten children of the Pasteur School in Detroit, Michigan. Of these, 31 were female and 19 were male. Their ages ranged from 61 months to 77 months, with a mean age of 69.8 months. See Table 1.[1]

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[1] Feigenbaum (6) has indicated that there are no significant differences between males and females in acquiring an understanding of the conservation concept.

TABLE 1
AGE AND SEX OF SUBJECTS

Age in months	Males	Females	Total
58-62	2	1	3
63-65	3	6	9
66-68	2	7	9
69-71	6	7	13
72-74	4	8	12
over 74	2	2	4
Total	19	31	50

According to a survey conducted by the Detroit Public Schools, this particular district is composed of 35 per cent Negro, 55 per cent Jewish, and 10 per cent white Christians. Of these, 62 per cent are middle-to-high income and 38 per cent are low income.

D. APPARATUS AND PROCEDURE

The apparatus used in this study were 14 large beads of like color, 14 three-quarter inch blocks of another color, three bottles, two of the same size and one clearly smaller than each of the other two.

To eliminate those who had already acquired an understanding of the conservation principle, a pretest was given:

1. *S* was presented with 14 beads and two glasses and, by provoked correspondence, was told to place beads into containers.

2. After the beads were placed, *S* was asked, "Are there more beads in one glass than in the other?" "Are there the same number of beads in one glass as in the other?" "Are there fewer beads in one glass than in the other?"

3. *S*'s understanding of correspondence consisted of answers that referred to the operation of provoked correspondence; i.e., "because we put them in two-by-two."

4. After questioning, beads from one container were poured by *E* into a smaller one (the level of beads rises). Questions of number constancy were again posed.

5. Understanding was apparent if *S* answered in conservation of set ("we poured them all out") or made reference to provoked correspondence ("because we put them in two-by-two").

*S*s indicating an understanding of the principle were eliminated. Remaining *S*s were placed randomly into three treatment groups.

1. *Reduction of Irrelevant Stimuli*

1. *S* was blindfolded and told, by provoked correspondence (pair of items), to drop the beads into large glasses. Questions of number constancy were asked.
2. *S* was told to pour the contents of one bottle into the smaller one. Questions of constancy (conservation) were asked.

These operations were performed to test for transfer without blindfold and using wooden blocks.

2. *Reinforcement by Addition and Subtraction*

1. *S* was shown a pile of beads. *E* added one bead and then asked whether or not the number of beads had changed.
2. If *S* did not say "yes" and explain the change adequately, *E* told *S* there were more beads because one was added. If *S* answered correctly, *E* repeated *S*'s answer. The same procedure was used for addition and subtraction.

The standard tests for conservation and correspondence were then administered.

3. *Combination of 1 and 2*

Because of the success attained by some experimenters in using a variation of the second treatment group (14), a second test was given if *S* failed the first test. The purpose was to see whether or not this combination would have any effect on *S*'s understanding of the conservation principle.

In analyzing the data, *S*s were placed into the two groups according to scores achieved on the "Detroit Beginning First-Grade Intelligence Test," a test given to all children in the Detroit Public School system before they enter first grade. *S*s with scores of C+ or above were placed in the "bright" group; those with C or below were placed in the "dull" group.

E. RESULTS

The results for each group are given in Table 2. There is a significant difference between treatment groups at the .01 level ($\chi^2 = 9.55$).[2] Of the 50 *S*s, only three had an initial understanding of the conservation principle. By means of the first treatment, 14 *S*s (of both intelligence levels) gained an understanding of the conservation principle. Only three *S*s in the second group learned the principle. These three were in the "bright" group.

As previously mentioned, any *S* failing Treatment 1 was administered Treatment 2. This study found that of the 16 who failed the first treatment,

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[2] Yates correction was applied.

TABLE 2
RESULTS FOR EACH TREATMENT GROUP ACCORDING TO INTELLIGENCE LEVELS OF *S*s

Treatment	Number passed	Number failed
Treatment 1 ($N = 30$)		
Bright	8	6
Dull	6	10
Treatment 2 ($N = 17$)		
Bright	3	6
Dull	0	8
Treatments 1 and 2 ($N = 16$)		
Bright	0	6
Dull	0	10

none could understand the principle after participating in the second group.

To see whether or not an understanding of the principle was maintained, the pretest was given one week later to those *S*s who had passed a treatment. The results of this can be seen in Table 3. Five of the "brights" in the first group, and five of the "dulls" retained the concept. In Treatment 2, two in the "bright" group and no one in the "dull" group retained the concept.

TABLE 3
*S*s RETAINING PRINCIPLE AFTER ONE WEEK

Treatment	Number passed	Number failed
Treatment 1		
Bright	5	1
Dull	5	1
Treatment 2		
Bright	2	1
Dull	0	0

F. DISCUSSION

This study was concerned with testing and comparing two methods of teaching the principles of correspondence and conservation to children. Several possibilities were suggested by this study. Method 1, *Reduction of Irrelevant Stimuli,* was comparatively successful with all intelligence levels. Method 2, *Reinforcement by Addition and Subtraction,* found far less success. Few *S*s could grasp the concepts after experience with this method and those succeeding were all of higher intelligence levels. Although the conditions for both studies were not completely equivalent, in comparing the results of this study with those of Wohlwill's, the trends indicate greater success with the reduction of irrelevant stimuli than with reinforcement by addition and subtraction.

Retention of the concept after one week proved successful for both methods. However, since the number of *S*s learning the concept by Treatment 2 was extremely small, it is difficult to assess the relationship between the two methods.

The question as to which learning theory most adequately explains the child's understanding of the conservation concept is still not settled. It is reasonable to assume (for this experiment) that experiences, such as manipulation of the beads and their placement by the *S*s into the glasses, may have been a decisive factor in understanding the concept; thus giving some credence to an equilibrium explanation.

G. SUMMARY

The purpose of this study was to test and compare different methods of teaching the principles of correspondence and conservation to children and to provide additional information on the child's acquisition of the conservation concept.

*S*s for this investigation were 31 females and 19 males, all of whom were members of kindergarten classes. Their ages ranged from 61 months to 77 months. *S*s understanding of the conservation concept was first measured by a pretest the results of which served to place *S* into one of three treatment groups.

The method of the Reduction of Irrelevant Stimuli was found to be more successful than Reinforcement by Addition and Subtraction. In addition, those who did learn the concept tended to retain this knowledge, at least on a short-term basis.

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TEST PERFORMANCE OF JEWISH DAY-SCHOOL STUDENTS*[1]

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A. PURPOSE

Among the perennial questions in measurement of intelligence are those concerning the effect of special experience on abilities and the age at which certain abilities (particularly perceptual ones) become relatively fixed. Some light can be thrown on both of these questions by studying groups which are subject to intensive and prolonged experience during elementary-school years; while at the same time they are not entirely isolated from the broad and general influence of contemporary North American culture. Children attending a Jewish day school constitute such a group. In a series of studies, B. M. Levinson has studied performance on the Wechsler intelligence tests of preschool children (2, 4, 5, 6, 8), of elementary-school children (5, 7, 8) and of university students (3, 5). His subjects were said to be, "typical products of the cultural mold exerted by traditional Jewish values" (3, p. 279). The preschool children were candidates for admission to a Jewish day school; the elementary-school pupils were attending such day schools; the college students were at Yeshiva University and had been Jewish day-school pupils. Levinson found significant differences (mean differences of approximately 20 *IQ* points) between verbal and performance *IQ*s of both the elementary-school and college groups, but no corresponding significant difference for the preschool children.

Levinson attributed the differences that occurred to the pressure exerted by the traditional Jewish culture towards verbal learning. The Jewish day school emphasizes verbal skills and tends to neglect performance arts. It acts as "an important agent in perpetuating and reinforcing those abilities thought important" (5, p. 150).

Levinson has also reported a study (7) in which WISC scores for Jewish day-school pupils, Irish Catholic boys attending a parochial school, and Italian Catholic boys attending another parochial school were compared. All groups

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[1] This paper is based in part on a thesis by the junior author completed as part of the requirement for an M.A. at Carleton University.

achieved a higher mean performance score than they did a verbal score, but, for the Italian boys the difference was not significant.

The studies reported are cross-sectional and it can be argued that the results would be less equivocal if there had been longitudinal measures taken. Levinson (8) has reported one study in which Jewish day-school pupils were retested, with a mean interval of about two years. There was a significant gain in verbal *IQ,* but not in performance *IQ*. However, this finding is not as convincing as it might have been if retest gains, which can be expected regardless of intervening experience, had been partialled out. [The lack of normative data on the contentious problem of retest gains has been the subject of a cry in the wilderness published elsewhere (10)].

The present study concerned a number of questions. Evidence derived in relation to two of these questions was of direct relevance to Levinson's work and will be reported here. These questions were (*a*) On the WISC, would Jewish day-school students in an urban Canadian environment show an atypical ability pattern similar to that obtained with New York children? (*b*) If an unusual ability pattern were found, would it be possible to specify (more precisely than the WISC allows) the nature of those abilities that deviate from established norms?

B. SUBJECTS

Four groups of children were tested.

1. *Group A*

Twenty-seven children in Grades 7 and 8 at Hillel Academy (an Ottawa Jewish day school) were tested on the WISC and on three tests of spatial-perceptual abilities (Thurstone's Concealed Figures, Cards, and Form-Board tests).

2. *Group B*

Thirty-four non-Jewish public-school children, who were matched with Group A for age, school grade, socioeconomic level, sex, and WISC Full-Scale *IQ* were given the same tests as Group A.

3. *Group C*

Forty-five Grade-1 students at Hillel Academy were tested on the WISC only.

4. *Group D*

Eighteen Grade 7 and Grade 8 Jewish students who attended public schools, but who took Hebrew classes at Hillel Academy from 6 to 8 p.m. on Monday through Thursday and Sunday morning.

C. RESULTS

The results obtained from testing are summarized in Table 1. Table 1 shows that Group A (Grade 7 and 8 Jewish day-school pupils) and Group D (Jewish public-school pupils) have a significantly higher verbal *IQ* than performance *IQ*. A similar difference was not found for the other groups. The main differences obtained for Groups B and C are not significant. The difference for Group D would not be significant if a two-tailed test were used, but a one-tailed test is appropriate because the direction of the difference was predicted on the basis of previous work. Although the difference for Group D is significant it is also tantalizing. This group is no more than an accidental sample. It is not known if it is or is not representative of Jewish children attending public schools in Ottawa. Therefore, although the test results of this group might give rise to some interesting speculations they would be idle.

TABLE 1
DIFFERENCES BETWEEN WISC VERBAL *IQ* AND WISC PERFORMANCE *IQ*

Group	Mean age	Mean verbal *IQ*	Mean performance *IQ*	Mean full *IQ*	Verbal *IQ* minus performance *IQ*	*t*
A	12.2	119.9	106.3	114.7	13.6	6.5**
B	12.4	113.7	113.2	114.7	.5	ns
C	6.4	109.2	106.6	108.7	2.6	ns
D	12.8	112.9	107.7	111.7	5.2	2.05*

* Significant at .05 level of confidence (one-tailed test).
** Significant at .001 level of confidence (one-tailed test).

TABLE 2
DIFFERENCES BETWEEN GROUP A AND GROUP B ON WISC VERBAL *IQ* AND WISC PERFORMANCE *IQ* AND THREE SPATIAL-PERCEPTUAL TESTS

Variable	Group A	Group B	Difference	*t*
Verbal *IQ*	119.9	113.7	6.2	1.96*
Performance *IQ*	106.3	113.2	6.9	2.09*
Concealed Figures	42.6	47.9	5.3	1.11
Cards	21.6	27.3	5.7	2.06*
Form Board	8.2	14.9	6.7	4.43**

* Significant at .05 level of confidence (one-tailed test).
** Significant at .01 level of confidence (one-tailed test).

The three spatial-perceptual tests were selected for the following reasons: (*a*) Significant differences between Groups A and B had been obtained on series for only the Block-Design and Object-Assembly Performance subtests of the WISC. (*b*) Factor analysis studies by Davis (1) and Maxwell (9) had shown these subtests to be factorially complex, but with significant loadings on what Davis calls visualization and on Maxwell's space-performance factor. (*c*) The three tests had been developed with a view to providing factorially pure tests.[2]

The intercorrelations (See Table 2) of the three Thurstone tests and the verbal and performance WISC *IQ*s yield some additional evidence for interpretation. For Group B (non-Jewish) there are significant correlations between each of the tests and performance *IQ* (.66, .63, and .52), but not with verbal *IQ* (.33, .22, and .24). For Group A (Jewish), the correlations with performance *IQ* (.82, .62, and .70) are significant, but with verbal *IQ* they are .52, .47, and .49.

The limited evidence presented here, on the whole, is consistent with that of many other investigations that have demonstrated cultural and subcultural influences on intelligence measurement. The findings are particularly consistent with those reported by Levinson. As Levinson has reported, a consistent disparity between verbal *IQ* and performance *IQ* for Jewish day-school pupils has been shown to have generality extending to a Canadian community (which only the members of the Tourist and Census Bureaus would agree to be urban).

The evidence presented is not, however, entirely consistent with Levinson's interpretation. The disparity in scores can be interpreted with equivalent logic as arising from a relative decrement (perhaps, lack of development) of performance abilities as well as from a relative increase in verbal abilities. In fact, the evidence derived from the Thurstone tests demonstrates a significantly lower ability to deal with spatial-perceptual tasks on the part of the Jewish children as compared with non-Jewish children. The significant correlation obtained between the spatial-perceptual tests and verbal *IQ* for Group A indicates that these students may have used verbal abilities in the solution of what were, for the non-Jewish public-school children, essentially spatial-perceptual problems. For example, it is possible, although less efficient, to establish, for each item on these tests, a verbal generalization that will lead to a correct solution.

It is obvious, since matching of Groups A and B was done on the basis of group means and various WISC Full-Scale *IQ* scores, that a lower mean on performance *IQ* in one group must be accompanied by a higher verbal *IQ* in the same group. However, matching on either verbal or performance *IQ* would not be likely to have rendered results that would be any less equivocal.

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[2] Permission to use the three spatial-perceptual tests in an experimental investigation was obtained from Dr. Thelma Thurstone.

D. Conclusion

We can agree without question that some combination of subcultural influence and a specific school curriculum has had a significant effect on the verbal abilities of the children in question. Additionally, it seems evident that these same influences have had an effect on abilities in the spatial-perceptual realm. The latter point has broader theoretical implications. A substantial literature has accumulated in the past few years on the subject of the importance of early experience (deprivation) on the development of perceptual abilities. The evidence presented here and by Levinson and by others indicates that the limits of learning in perceptual abilities may not be reached at as early an age as is commonly believed.

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STABILITY OF AVERAGE INTELLIGENCE*[1]

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A. PURPOSE

A question of continuing interest to psychologists is, "What happens to individual ability over time?" Because of this interest, a considerable body of evidence exists on *IQ* constancy and change with age. Early cross-sectional research, as exemplified by the classical Jones and Conrad study (4), showed a leveling of ability in the late teens or early twenties, followed by a slow but accelerating decline with age. Longitudinal studies, on the other hand, have uniformly shown gains in tested ability with age. Two studies which have attracted considerable interest are those reported by Bayley and Oden (2) on the Terman gifted population, and by Owens (5) on a group of former college students. In a 1955 discussion of research Bayley generalized: "We have here evidence that tested intelligence, as measured by verbal concepts and abstractions, continues to grow when populations composed primarily of superior adults are tested" (1). While most research has been carried out on superior populations, at least one study has been reported on a population originally classed as mentally deficient (3). In this study, as in those at the other end of the scale, a considerable rise in tested ability and performance is found in the early forties.

Longitudinal studies, as typified by those cited, have concentrated on either end of the intellectual continuum. The great bulk of the population in the middle range of abilities—the "average-man" group—has been neglected. Because generalizations valid for the high and low groups may not be valid for the middle half, study of the average seems to be desirable.

The purposes of the study reported here were (*a*) to determine whether a mature population identified as "average" in childhood could be located, (*b*) to retest a sample of this population, and (*c*) to determine what environmental factors might have influenced any changes of ability found.

Such studies are difficult, expensive, and time-consuming. Accordingly, a

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[1] Data from a thesis presented by Suzanne Truesdell James to the faculty of the Graduate College of Iowa State University in partial fulfillment of requirements for the degree of Master of Science, 1962.

small grant was secured[2] and this research was undertaken as a pilot study to determine whether a major undertaking would be feasible.

B. PROCEDURE

1. *Subjects*

The names of potential subjects of this study were drawn from departmental files containing test scores and a few other items of information on 1,200 persons. This population had been routinely tested by trained psychologists in the early school years in a midwestern community.

"Average" subjects were chosen from this file by selecting subject data-cards with 100 *IQ* score, then 99 and 101, and so on. Twenty-five subjects were located and agreed to be retested. Originally, they had been tested at an average age of six and had a mean *IQ* of 100.2.

2. *Instruments*

About half of the subjects had been tested originally with the 1916 or 1937 Stanford-Binet. The rest had been examined with the Kuhlman-Anderson or the Detroit Kindergarten tests. For the retesting, the Otis Quick-Scoring Mental Ability Test, Gamma Form AM, was used.

To determine the effect of environment on possible changes of *IQ* score, a biographical inventory was used. This biographical inventory consisted of 66 items with possible response-choices ranging from four to a maximum of 20. It was administered with no time limit.

Items were designed to tap experiences usually associated with the development of intelligence: parents' education, stimulating experiences of various kinds, academic training, and the like.

3. *Retesting*

Subjects were traced from biographical data in the departmental files. Locating subjects after a period of several years always poses problems. Many have moved away, and female subjects are particularly hard to locate because of name changes. However, 14 males and 11 females were located in their home community. Lack of adequate research funds made it necessary to confine the study to this one city.

Upon being located, most potential subjects proved to be cooperative and few difficulties were encountered in gathering data. All tests were given in the homes (or occasionally offices) of subjects, with the Otis test administered first, followed by the personal-data blank.

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[2] Gratitude must be expressed to the Iowa State University Research Foundation for the grant which made this study possible.

4. *Statistical Method*

The difference between early *IQ* and present *IQ* was obtained for each subject. Difference scores were then analyzed in relation to the responses to the items in the biographical inventory. Responses chosen by fewer than 28 per cent of the respondents or by more than 72 per cent were not analyzed.

To test the significance of the items in the biographical inventory, an analysis of variance was carried out for each item (on the IBM 650). For each item, significance was tested by the F ratio. To test for linear or quadratic relationships between the ages of the subjects and their difference scores, product-moment correlations were computed (on the IBM 650) and tested for significance.

C. RESULTS

1. *Subject Characteristics*

Fourteen males and 11 females were located and tested. All the male subjects had completed high school, but one female had not gone beyond the eighth grade. Three males and five females had attended college, but had not graduated. Four males and three females had graduated from college. In addition, two males had done some graduate work.

Occupations of parents of the subjects ranged all the way from unskilled labor to professional work. Business and professional categories were most frequent. The subjects themselves reported almost as great a variety of occupations as did their parents. Male occupations ranged from unskilled labor to teaching in both public school and college. Female occupations were most frequently in the clerical and sales area; although other jobs were cited: reporter, advertiser, camp counselor, and the like.

2. *Test Characteristics*

Retest *IQ* scores for the subjects ranged from 90 to 132, with an average retest score of 107.6. To determine change, if any, in intelligence-test score, the difference between each subject's initial *IQ* and his retest *IQ* was found. The difference scores ranged from —8 to +29. Data on initial *IQ*s, retest *IQ*s, difference scores, and ages of the subjects are found in Table 1.

At the .05 level, only one item from the biographical inventory is statistically significant in accounting for variance in the difference scores. This item is: "What did you usually do during your school days when you found

TABLE 1
SUBJECT CHARACTERISTICS AND OBTAINED *IQ* SCORES

Subject	Sex	Original test age	Retest age	Original test	Original *IQ*	Retest *IQ*	Difference
1	M	6	28	S-B[a]	101	93	— 8
2	F	13	42	K-A[b]	98	90	— 8
3	M	8	40	K-A	99	94	— 5
4	M	3	38	S-B	100	98	— 2
5	M	7	28	S-B	99	100	+ 1
6	F	8	26	K-A	98	100	+ 2
7	M	8	28	K-A	103	105	+ 2
8	F	5	36	D-K[c]	100	103	+ 3
9	F	6	28	S-B	99	103	+ 4
10	F	10	30	K-A	100	105	+ 5
11	F	6	41	K-A	104	109	+ 5
12	F	6	32	S-B	104	111	+ 7
13	M	6	29	S-B	100	108	+ 8
14	F	7	31	S-B	100	108	+ 8
15	F	6	28	S-B	96	104	+ 8
16	M	5	38	D-K	103	114	+ 9
17	F	5	34	D-K	100	112	+ 12
18	M	5	33	D-K	100	112	+ 12
19	M	6	28	S-B	100	113	+ 13
20	M	6	40	D-K	99	112	+ 13
21	F	6	41	S-B	100	113	+ 13
22	M	6	27	S-B	99	113	+ 14
23	M	6	33	D-K	100	116	+ 16
24	M	6	31	D-K	99	122	+ 23
25	M	7	40	K-A	103	132	+ 29

[a] S-B, Stanford-Binet.
[b] K-A, Kuhlmann-Anderson.
[c] D-K, Detroit-Kindergarten.

problems hard to understand? (*a*) asked teachers or parents for help, (*b*) asked schoolmates for help, (*c*) did some background reading, (*d*) dug until the problem was solved, (*e*) none of these."

Thirteen subjects indicated that they asked teachers or parents for help, five indicated that they asked schoolmates for help, three responded that they did some background reading, and four indicated that they dug until the problem was solved.

The remainder of the items from the biographical inventory, while not statistically significant in accounting for variance in the difference scores of the subjects in the present study, were suggestive of certain subject-characteristics. Some of the items that approached statistical significance will be reported for their possible suggestive value.

One such item was, "How much schooling did your father have?" Response choices ranged from "through junior-high school" to "through college." Another was, "How did your parents or guardian feel in regard to your going to college?" Responses ranged from "Did not want you to go." to "Constantly impressed on you the need of a good education." A third item was, "Have you worked for pay as a businessman, assuming risk and management duties?" This item carried only "yes" or "no" choices.

In the work context, was the question, "In your ideal job, which would you prefer?" with responses indicating preference for a single activity, a variety of activities, or a combination. In another area was the question, "How many magazines and periodicals do you read consistently?" with responses ranging from 0 to 7.

The analysis of age in relation to difference scores indicated that age did not correlate significantly either linearly or quadratically with the difference scores for the subjects in the present study.

D. Discussion

The most striking finding of this study was the great diversity of characteristics exhibited. Test scores ranged from the lower end of the average range to the superior level, and occupations ranged from unskilled labor to professional work.

The population is too small to permit generalization. The representativeness of the subjects is always a problem in longitudinal studies, and the difficulty increases when choice is confined (as it was in this case) to the original small community. The question of selectivity in emigration, the existence of sex differences in choice of activities, the death of subjects—these factors contribute to possible unrepresentativeness of the sample.

In longitudinal research, another problem occurs in deciding whether to use the original tests or to use newer and perhaps more convenient instruments. The decision to use a different test was easier in this case than it is sometimes because the problem is less acute when the middle part of a distribution, rather than either end of a distribution, is being studied. The familiar problem of regression is minimized for the same reason.

The absence of life experiences highly related to *IQ* change has several possible explanations. (The writers do not feel that the one statistically significant item relating to securing help on problems has much practical meaning.) One possibility is that no relationship does in fact exist; another is that the life-history blank was inadequate to reveal relationships; a third is that too few cases were studied to reveal the existence of meaningful relationships. The writers feel that the latter is the most probable explanation. But, some of the items that approach significance suggest lines of inquiry to follow in the future.

Because age at original testing and age at retesting was not consistent for all subjects, it was felt that correlation of difference scores and age might have been influenced. As age did not appear to correlate either linearly or quadratically with the difference scores, it would appear that the growth curve for intelligence for these subjects, in general, was not rising or declining. Curves for individuals might, of course, be changing markedly.

Should the study be pursued? No marked trend in intellectual change was observed in this population or were any experiences revealed which are clearly related to change. However, the considerable range in adult intelligence scores, education, and vocational achievement suggests that further study of this group or of a similar "average" group would be of profit if carried out on a scale that would insure adequate sampling of the original population. With the current emphasis on education and career planning, it would be unfortunate if all "average" children in the lower grades were assumed to be alike in probable future development.

E. Summary

The purpose of this research was to examine trends in intelligence in an "average" population over a period of several years. A second purpose was to search for experiential antecedents of change.

Twenty-five subjects, 14 males and 11 females, at an average age of 33, were located out of an average-ability population originally tested in childhood. Retest *IQ* scores ranged from 90 to 132 with an average of 107. Educational achievement ranged from junior-high school to graduate school and occupations from unskilled labor to professional work. One item of a biographical inventory was found to relate significantly to *IQ* change, and several others approached significance.

The great diversity of this population, described as "average" in childhood, suggests that caution should be exercised in making plans for the future of "average" youngsters.

A larger and more representative "average" population sample must be studied before generalizations can be made about their development.

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EFFECTS OF FRUSTRATION OF THE NURSING PROCESS ON KITTENS*[1]

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A. Introduction

This study is an attempt to explore the effects of frustration of the nursing process on kittens with respect to their physical condition, temperament, and their reaction to a specific stress condition (air blast).

A search of the literature does not indicate the presence of studies involving frustration of the nursing process in kittens. However, studies involving early food deprivation in animals are reported by Hunt (3), Elliot and King (1), Mandler (5), and Guze (2). In the study by Elliot and King (1) in which one group of seven puppies—from four to seven weeks of age—were given a reduced diet, and a control group was fed ad libitum, tests at 13 weeks of age showed that deprived puppies are significantly retarded in weight in comparison to nondeprived puppies, despite the fact that the deprived puppies had opportunity to catch up between the seventh and thirteenth week. Mandler (5) reported that there was no difference in exploratory behavior, but that deprivation animals show accelerated consummatory behavior when compared to those given ad libitum feeding. Levine (4) reports that, under conditions of maternal deprivation, rats develop at a retarded rate and are more susceptible to disease, but this result may have been due to the simple lack of stimulation.

B. Experimental Method

Two litters of kittens, four in each, were frustrated during the nursing process. In the first litter (Litter A) this process was begun approximately 72 hours after birth. In the second litter (Litter B), it was begun 16 hours after birth. The method employed was that of forcing the mother cats to move away from the kittens, by the pressure of a 2-1/2 foot aluminum rod inserted through the cage openings. No physical damage was sustained by the mother cats or the kittens through the use of this rod.

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[1] The author wishes to express his appreciation to Frank Whalen, animal caretaker, for his assistance in helping to carry out this experiment. Also, acknowledgment is made to Michael Ross, D.V.M. for his evaluation of the litters, and to Theodore Willers, Chief, Medical Illustration Service, for the photographs taken.

For Litter A (4 kittens) the mean time of interference during the nursing period for 13 days (not including weekends) after commencement of the experiment was 1.04 hours. This was done during the ordinary eight-hour working shift. The kittens were able to nurse ad libitum during the rest of the time. The mean time for interruption of the nursing process in Litter B (4 kittens) was 1.47 hours, for a period of 13 "working days." In Litter B the kittens were also allowed to nurse ad libitum during the rest of the day.

The range of nursing interruption time in Litter A extended from 37 to 191 minutes. In Litter B this range was from 75 to 281 minutes.

Although the actual time of the interference with the nursing process may appear small, it constituted a high percentage of the nursing time under ordinary circumstances, as observed in a control group, Litter C (3 kittens). Conditions in Litter C were comparable to those existing for Litters A and B except for the experimental variable of nursing interference.

C. RESULTS

In litter A, three kittens died 17, 20, and 67 days after birth. In Litter B, one kitten died after 35 days. No mortality was observed in litter C.

At the time of examination by a consulting veterinarian (66 days for Litter A and 54 days for Litter B) all kittens were below expected weight, showed abnormalities of hair and skin, and seemed generally frightened and nervous. However, the kittens of Litter A seemed less frightened than those of Litter B. These conditions were in marked contrast to those for the kittens in Litter C at 70 days, at which time the report stated that the physical condition and size were normal. So were the skin and hair. No nervousness or frightened reaction was in evidence. A similar independent appraisal of kittens in all three litters was made by our animal caretaker, a person with over 10 years' experience.

Some of the behavior displayed by the experimental kittens included periods of apathy and sleep-like behavior and, on rare occasions, unexpected aggressive reactions. This behavior was in marked contrast to that of the control group in which group the kittens were generally alert and attentive.

A difference in behavior between the experimental litters and the control litter was noted when a modification of the technique utilized by Masserman (6, p. 62) was introduced. All of the kittens were removed from their cages and placed on a table. Then an air blast from an ordinary balloon was directed at their faces. This was repeated for a total of 15 times for each kitten. The experimental kittens seemed generally to show extreme fear and remained "frozen" in a hunched position in a persistent, nonadjustive manner. All the kittens in the control group either attempted to strike at the balloon or made an effort to get out of the way of the blast of air.

An examination of the behavior of the experimental mother cats toward their litters merits attention. As a result of the frequent frustration of their need to nurse, the mother cats showed signs of anger and tried to bite the aluminum rod or attack it with their claws. This approach was soon supplanted by their eating or drinking during the period of frustration, or by their moving away. After three days of experimental interference, the mother cats would move away from the litter when the rod merely touched their back. Then a stage was reached in which the mother cats spontaneously would leave the kittens in the midst of the nursing period and return after a short time and resume nursing, thus indicating that conditioning had been effected. At other times the kittens would show every indication of wanting to nurse, but the experimental mother cats would completely ignore them, either going to another corner or else eating, as may be seen in Fig. 1.

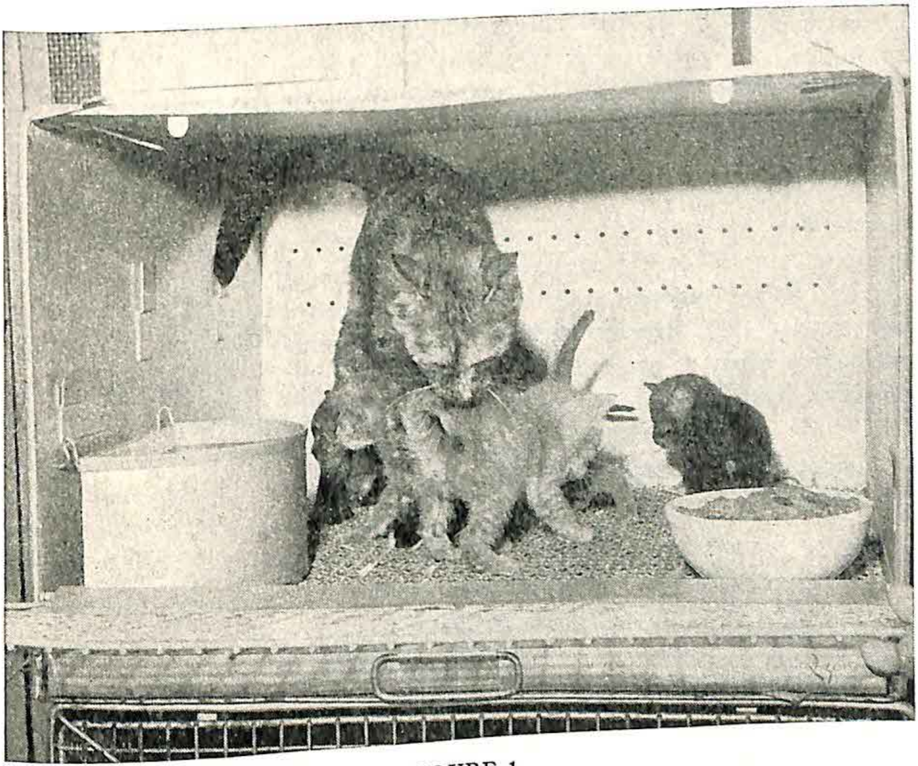

FIGURE 1

Mother Cat Has Just Left the Litter in the Middle of the Nursing Process

D. Discussion

The results reported by Levine (4, p. 86) concerning greater susceptibility to disease and development at a retarded rate in rats under conditions of maternal deprivation are confirmed in this investigation. In two of the experimental kittens which died there appeared to be a "wasting away" which might be likened to marasmus, a condition described by Ribble (7, p. 634). This may have resulted from the rejection of the hungry kittens by the experimental mother cats.

The physical condition of the experimental litters would seem to be similar to that reported by Elliot and King (1) for the group of deprived puppies. However, what seems to be noteworthy in this experiment is that the kittens were given complete freedom to nurse ad libitum for 16 hours of each experimental session. Apparently, the stress imposed was sufficiently great to prevent "a catching up" and a regaining of their expected physical weight.

It may be hypothesized that the tendency of the experimental kittens to huddle together and to maintain contact with each other possibly aided them in resisting some of the stress effects. This behavior would be consistent with Masserman's hypothesis (6, p. 106) that cats, whether directly or indirectly, certainly do influence another's normal and abnormal behavior to the extent that the reciprocal relationship impedes or facilitates the satisfaction of each animal's needs.

The marked increase of anxiety (or "fear and nervousness" as described by the veterinarian) in the experimental kittens may have directly resulted from the stress imposed by the frustration of the nursing process. Certainly the behavior of the experimental kittens, when confronted by the stress of the air blast, showed that they lacked ability to cope with a new situation. Their maladaptive behavior persisted.

Finally, it has been shown that, as a result of a conditioning process instituted while in the process of nursing, a mother cat can be caused to have an ambivalent attitude toward her kittens. It would appear highly desirable to repeat the experimental procedures on a 24-hour basis to determine more clearly the effects of the conditioning process, as well as the effects on the kittens' future behavior.

E. Summary

Two experimental litters of kittens were subjected to frustration of the nursing process for a period of 13 days. In one litter, the process was begun 72 hours after birth and in the second litter, 16 hours after birth. By means of an aluminum rod, this was effected forcibly by moving the mother away

from the litter. Some of the results are (*a*) a higher mortality rate and impaired physical condition in the experimental litters as compared to the control litter, and (*b*) persistent maladaptive, nonadjustive reactions to a stress condition (air blast), were noted in the experimental kittens. Finally, it proved possible to condition mother cats to leave their young in the midst of the nursing process.

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ETHNIC AWARENESS IN RELATION TO MINORITY GROUP MEMBERSHIP*

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A. INTRODUCTION

The development of ethnic awareness in young members of an ethnic minority has constituted a topic of lasting interest and some controversy among American investigators. It is generally agreed that ethnic awareness in children (from both majority and minority groups) increases with age (1, 2, 3, 5, 6, 9, 11, 12, 14, 15, 17). There is also some evidence that degree of skin pigmentation in minority group *S*s is positively correlated with level of ethnic awareness (4, 5, 8). The dispute arises on the question of whether there are differences in degree of awareness when comparing *S*s from majority and minority groups. For example, studies by Horowitz (13), by Hartley, Rosenbaum, and Schwartz (11, 12) and by Goodman (9) have indicated that membership in an ethnic minority facilitates relatively early development of ethnic awareness. Other studies, however, by Goodman (7), Landreth and Johnson (14), Morland (15), and Stevenson and Stewart (17) have yielded opposite results.

To some extent, this conflict between findings stems from interstudy differences in the measuring instruments employed. In particular, when the criterion of awareness is the ability of *S* to identify with an own-race figure (usually a doll or a picture), any underlying preference for majority group figures in general is likely to induce identification with similar figures, among children from a minority group (7, 15). On the basis of such evidence, however, the question of whether the majority group and the minority group differ in the ability to discriminate ethnic differences remains unanswered.

In a previous paper (18), the author suggested an operational approach to the problem of ethnic awareness, which approach was treated as a conceptual process, according to which awareness levels are definable in terms of specified experimental tasks. It was hypothesized that the ontogenetic appearance of phenomena relating to the formation of an ethnic concept would be (*a*) identification by race with own-race figures, (*b*) discrimination by race between figures

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differing by race, and (*c*) attainment of a concept of race. Findings indicated that the development of the ethnic concept, "Maori," could be traced through the three stages outlined above, among White New Zealand children ranging in age from 4 through 12 years.

B. PROBLEM

The present research was guided by two aims: (*a*) To provide cross-cultural evidence relating development of ethnic awareness to the variables of age, skin pigmentation, and parental race among minority group *S*s. (*b*) To test further the adequacy of an operational approach to the development of ethnic awareness, using *S*s who are members of an ethnic minority rather than of an ethnic majority.

C. METHOD

1. *Subjects*

*S*s were 180 Maori children enrolled in a number of nursery and primary schools in Wellington, New Zealand, a city with a population (in 1960) of 237,000 whites (henceforth referred to as pakehas) and 3,500 Maoris. The children ranged in chronological age (CA) from 4 through 12 years, 20 *S*s being assigned to each of nine age groups at successive one-year intervals. The group means by age (years and months) were as follows: 4:1, 5:4, 6:0, 7:0, 8:11, 10:0, 10:11, 12:1. All groups were divided evenly according to sex.

2. *Determination of Skin Pigmentation and Parental Race*

During the course of test administration, *E* made a subjective estimate (on a three-point scale) of each *S*'s degree of skin pigmentation. Skin color was rated as either dark (D), medium (M), or light (L). Unfortunately, this rating was not made at the beginning of the present study, so that the results on this criterion are confined to an *N* of 121 (instead of being 180). The smaller *N*, however, was distributed evenly over the age range from 4 to 12. Although a direct measure of rater reliability was not undertaken in this research, some estimate of the validity of the ratings—by means of correlating degree of skin pigmentation with parental race—is available and is referred to in the results.

At the conclusion of each testing session, *E* obtained information concerning the race composition of *S*'s parents. In more than 75 per cent of the cases, *S*'s report could be checked against school records or with the report of a teacher who had met both parents. On the basis of this information, *S*s were categorized as either having parents who were both full Maori or part

Maori; i.e., neither was pakeha (no P); or as having one parent full Maori or part Maori, together with one pakeha parent (one P). This dichotomy was selected on the assumption that, if parental race is significantly related to ethnic awareness among Maoris, then this relationship will be highlighted in the particular case of Maori children having one full-pakeha parent.

3. *Experimenter*

In the previous study (18), a pakeha *E* tested pakeha *S*s. In the present study *E* was a Maori, being a psychology student recommended for the research by the Department of Maori Affairs. *E* was darkskinned and his features were unmistakably Maori. Both of his parents were Maori and his command of the English and Maori languages was fluent. The testing procedure was thoroughly rehearsed to ensure comparability between the administrative conditions of the previous study and the present one.

4. *Materials*

There were seven tests of ethnic awareness consisting of doll and picture materials. Briefly, the tests and their requirements are indicated in Table 1.

The tests were constructed to provide data relating to three successive levels of ethnic awareness. The Identification tests were designed to measure low-level awareness, the Discrimination and Assembly tests were designed to measure medium-level awareness, and the Classification tests were to measure high-level awareness.

TABLE 1

SEVEN TESTS OF ETHNIC AWARENESS, THE ETHNIC FIGURES USED, AND THE TASK OF THE SUBJECT

Title of test	Figures	Task of subject
1. Picture Identification	Three Maoris and three pakehas	Which one looks like *S*?
2. Doll Identification	One Maori and one pakeha	Which one looks like *S*?
3. Picture Discrimination	Two Maoris and one pakeha; One Maori and two pakehas	Which one is different?
4. Doll Discrimination	Two Maoris and one pakeha[a]	Which one is different?
5. Doll Assembly	One Maori and one pakeha	Make these pieces into two dolls.
6. Doll Classification (A)	Maori doll in Maori clothing	What kind of doll is this?
7. Doll Classification (B)	Maori doll in pakeha clothing	What kind of doll is this?

[a] In the previous study, one Maori and two pakeha dolls were administered to pakeha *S*s.

Further information concerning the structure and implications of the tests is available (18).

5. *Procedure*

As in the previous study (18), the picture material was administered before the doll material. The tests were imbedded within a larger battery relating to ethnic attitudes, the results of which are reported elsewhere (19). *S*s were tested individually with an average testing time of 15 minutes.

D. RESULTS

The proportion of *S*s at each age, from 4 through 12, making correct responses on each of the seven tests is shown in Table 2.

An overall analysis of the results showed that, to each of the seven tests, the general tendency for all *S*s ($N = 180$) was to make significantly more correct responses than incorrect responses. The seven means ranged between .62 and .92, and the critical ratios were significant at the .01 level. For tests 2, 3, 5, 6, and 7 the proportions of correct responses were found to be positively correlated with age ($p < .01$). A similar trend ($p < .05$) was observed for Test 1. For Test 4, the tendency for correct responses to increase with age levelled off at early age levels. For all tests, there was a similar trend: the proportion of correct responses increased with age until a stable level of performance was attained.

More detailed analysis of the results determined (for each test) the earliest age level at which a significant majority of *S*s made correct responses. This analysis is incorporated in Table 2 in the form of asterisks. The asterisks indicate the earliest ages at which mastery of each of the seven tests was achieved.

The mean proportions of Maori *S*s responding correctly to the seven tests, together with the related ages of mastery, were then compared with the relevant pakeha data previously reported (18). This comparison is shown in Table 3 (age of mastery in parentheses), with an analysis of differences by ethnic group.

In can be seen from the results in Table 3 that the pattern of mastery among Maori *S*s does not follow the sequence observed with pakeha *S*s. The Identification tests and the Picture-Discrimination test were not mastered until about 9 to 10, being significantly later in terms of age when compared with pakeha *S*s' performance. With respect to the four remaining tests, however, mastery was achieved at ages comparable to those noted for pakeha *S*s.

Results pertaining to the variables of skin pigmentation and parental race

TABLE 2

PROPORTION OF 20 MAORI CHILDREN AT EACH OF NINE AGE LEVELS MAKING CORRECT RESPONSES ON SEVEN AWARENESS TESTS

Test	Age											
	4	5	6	7	8	9	10	11	12	Mean	*CR*	Rho
1. Picture Identification	.65	.40	.40	.60	.60	.65	.90*	.80	.80	.64	3.87	.733
2. Doll Identification	.40	.45	.55	.55	.55	.75*	.90	1.00	.90	.67	4.62	.967
3. Picture Discrimination	.48	.45	.53	.55	.53	.58	.73[a]*	.88	.83	.62[b]	na	.946
4. Doll Discrimination	.65	.80*	1.00	.90	1.00	.95	1.00	1.00	.95	.92	11.18	na
5. Doll Assembly	.10	.30	.45	.75*	.90	.90	.95	1.00	1.00	.71	5.51	.992
6. Doll Classification (A)	.40	.35	.40	.85*	.85	.90	1.00	1.00	1.00	.75	6.71	.958
7. Doll Classification (B)	.30	.25	.30	.65	.60	.85*	.85	.95	.95	.63	3.58	.946

[a] Based on data derived from two sets of three pictures ($\chi^2 = 5.05$, $df = 2$, $p < .05$).

[b] $\chi^2 = 25.10$, $df = 2$, $p < .001$.

* Significant at the .05 level.

TABLE 3
MEAN PROPORTIONS OF CORRECT RESPONSES AND AGE OF MASTERY FOR PAKEHA AND MAORI SUBJECTS ON SEVEN AWARENESS TESTS

		Test						
Ethnic group	N	Picture Identification	Doll Identification	Picture Discrimination	Doll Discrimination	Doll Assembly	Doll Classification (A)	Doll Classification (B)
Pakeha	180	.92 (4)	.83 (5)	.68 (6)	.91 (5)	.79 (7)	.82 (7)	.61 (10)
Maori	180	.64 (10)	.67 (9)	.62 (10)	.92 (5)	.71 (7)	.75 (7)	.63 (9)
Difference between means (χ^2, $df = 1$)		37.36***	10.80**	9.07*[a]	0.03	3.33	2.38	0.19

* $p < .02$.
** $p < .01$.
*** $p < .001$.
[a] $df = 2$.

are shown in Table 4. The proportions of *S*s, graded by skin pigmentation (darkskinned, D; medium-skinned, M; or light-skinned, L), and by race composition of parents, making correct responses on each of the seven awareness tests are indicated.

The results in Table 4 reveal that darkskinned *S*s show a marked tendency to identify with own-race figures on the Picture- and Doll-Identification tests. Medium-skinned *S*s show a similar though not so pronounced tendency. Light-skinned *S*s tend to identify with other-race figures. The differences between the three groups are significant on both of the awareness tests ($p < .01$; $p < .001$). No significant group differences are observed on the Picture-Discrimination, Doll-Discrimination, and Doll-Assembly tests; in fact, on the Discrimination tests there is no trend whatsoever by skin pigmentation. Significant group differences are observed on the Doll-Classification tests (A and B), but are limited to a difference of light-skinned *S*s versus M and D *S*s; the former tend to make fewer correct responses than the latter.

The results in Table 4 also reveal that, on the Picture- and Doll-Identification tests, no-P *S*s tend to identify with own-race figures to a significantly greater extent than one-P *S*s. No significant group differences by parental race are observed on the remaining awareness tests.

Up to this point, the measures of skin pigmentation and parental race have been treated as though discrete. Empirically and theoretically, however, some overlap between the two factors is expected. To test this possibility, those protocols that included information on both measures were analyzed and the

TABLE 4
Proportions of Maori Children, Graded by Skin Pigmentation and Parental Race, Making Correct Responses on Seven Awareness Tests

Test	Skin pigmentation D ($N = 46$)	M ($N = 26$)	L ($N = 49$)	Difference (χ^2, $df = 2$)	"Race" of parents no P ($N = 99$)	one P ($N = 61$)	Difference (χ^2, $df = 1$)
1. Picture Identification	.83	.65	.37	10.77***	.68	.49	5.26**
2. Doll Identification	.91	.65	.47	20.08****	.73	.54	5.66**
3. Picture Discrimination	.67	.54	.60	5.85[a]	.56	.63	0.76[b]
4. Doll Discrimination	.93	.85	.94	2.21	.91	.92	0.07
5. Doll Assembly	.78	.77	.61	4.06	.73	.69	0.24
6. Doll Classification (A)	.83	.92	.65	8.18**	.77	.70	0.72
7. Doll Classification (B)	.70	.77	.45	9.55***	.62	.61	0.01

* $p < .05$.
** $p < .02$.
*** $p < .01$.
**** $p < .001$.
[a] $df = 4$.
[b] $df = 2$.

proportions of no-P *S*s and one-P *S*s in each of the three categories were calculated. The results are shown in Table 5.

TABLE 5
PROPORTIONS OF MAORI CHILDREN GRADED BY SKIN PIGMENTATION AND PARENTAL RACE*

Parents	Dark	Skin pigmentation Medium	Light
No P	.95	.90	.32
One P	.05	.10	.68

* $C = .542$; $\chi^2 = 43.99$, $df = 2$, $p < .001$.

The results in Table 5 indicate that 95 per cent of the no-P *S*s were rated as having a dark skin; whereas, at the other extreme, 68 per cent of one-P *S*s were rated as having a light skin. These data yield a contingency coefficient of .542, which is significant at the .001 level. A correction for class index (10, pp. 358-359), which renders this statistic comparable to the more familiar product-moment coefficient, gives a coefficient of .764.

In common with the previous study (18), no consistent or significant sex differences were found in any aspect of the research.

E. DISCUSSION

The general observation (in American developmental studies of ethnic awareness) that awareness increases with age among both majority and minority group members is supported in this study, as well as in the previous one (18).

Differential effects of majority and minority group membership within New Zealand, however, are apparent. Among pakeha *S*s, it has been observed that ethnic awareness can be traced ontogenetically through successive stages of identification, discrimination, and attainment. Among Maori *S*s, the present findings indicate that awareness development is generally comparable to the above, with two exceptions.

In the case of the Picture Discrimination Test, there is a slight, but consistent tendency (in the range 4 to 9) for Maori *S*s to make fewer correct responses than pakeha *S*s. A possible explanation of this finding is that the test in question is structurally similar to those included in many *IQ* scales, under the name of "performance tests."[1] Using a rural sample of Maori and pakeha children, Ritchie (16) found that Maoris tend to score lower on tests of this kind, a finding attributed to the impoverished intellectual environment in many Maori homes. In the present case, however, no information is available concerning the nature of the *S*s' home environment.

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[1] The Doll-Assembly and Doll-Discrimination tests can also be regarded as performance tests. And in fact, a finding of marginal significance ($p < .10$) indicated that Maoris also performed more poorly than pakehas on the Doll-Assembly Test. No differences by ethnic group, however, were observed on the Doll-Discrimination Test. In this instance, a correct response is relatively simple in that the stimulus materials used are identical except for the cue of skin color; whereas in the case

The results pertaining to the two Identification tests leave little room for doubt that own-race identification in the range 5 to 9 is much less frequent among Maoris than among pakehas. This finding is similar to those reported for Negro minorities in the United States (7, 15, 17) Morland's interpretation of minority group identification with a dominant, privileged race (15), is a likely explanation of the present result. On the New Zealand scene, this interpretation is favored by evidence of other-race preferences by Maoris during the childhood years (19). Maori-pakeha differences in response to Identification tests, however, tend to decrease after 6 and by 10 there are no apparent group differences.

The other variables investigated specifically relating to minority group membership; namely, skin pigmentation and parental race, provide a picture that tallies with American reports. In this study, it was found that the tendency to identify with own-race figures is less marked among lighter-skinned Maoris than among darker-skinned Maoris. This finding is similar to the Clarks' observation (4, 5) concerning patterns of identification in Negro children. In the present study, it was further noted that *S*s with one parent a pakeha, rather than with both parents part Maori or full Maori, tended to identify more frequently with pakeha figures. This finding is partly though not completely derived from the observed dependence between the measures of skin pigmentation and parental race, a point which is to be discussed further.

It seems unlikely that, in response to tests involving identification, differences by skin pigmentation indicates real differences in awareness of ethnic characteristics; although other investigators (5, 8) have reached such a conclusion. Considering the more "objective" tests used in the present study (*cf.* 18), i.e., the Discrimination and Assembly tests, no significant differences by the variable of skin pigmentation (or parental race) were observed. It would seem that these factors are of significance only where the self-concept is directly involved, as in experimental tasks involving identification. With respect to the present results on the Doll-Classification tests (A and B), it was observed that correct responses occurred less frequently among light-

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of the Picture Discrimination Test there were added conflicting cues relating to clothing, hair, and direction of gaze, making the picture test a more difficult task to perform.

skinned *S*s than among medium-skinned or darkskinned *S*s. Interpreting this finding within the context of what has been said earlier, it does not seem likely that light-skinned *S*s are less aware than others of ethnic differences or are more deficient in their concept of "Maori." Rather, it appears that light-skinned *S*s are simply reluctant to verbalize on ethnic matters, as is required in responding correctly on the Classification tests. Parental race was not found to be a relevant factor here.

Of minor interest is the indication that the measures of skin pigmentation and parental race are interdependent. This finding, together with observed similarity in response trends associated with the two measures, provides partial validation for *E*'s ratings of skin pigmentation. At the same time, the dependence reflected in an *r* of .764 is not complete. For example, the results in Table 5 show that 32 per cent of no-P *S*s were rated as having light skin. The parents of such *S*s, possibly, were both light-skinned and part Maori. This could mean that some no-P *S*s, who are also light-skinned, respond to the tests as light-skinned rather than as dark-skinned, and so on. On this basis, both measures would have value for predictive purposes.

The chief conclusions to be drawn from the present study are as follows:

1. American findings that ethnic awareness among both majority and minority group members increases with age are supported.

2. The proposition that awareness develops through successive stages of identification, discrimination, and attainment seems to be limited to describing an ethnic-majority population. Among minority group members, it appears that the initial stage of identification is displaced chronologically to a position following the stage of discrimination. This finding is interpreted as indicating identification, by a minority group, with a privileged ethnic majority.

3. Interpretations concerning levels of ethnic awareness, particularly with reference to supposed majority-minority group differences, are not warranted unless the "levels" are operationally defined and their relationship to the measuring instruments are specified.

4. Degree of skin pigmentation among minority group members is positively correlated with own-race identification. American findings are supported in this instance. The related variable of parental race seems to operate in a similar fashion.

5. The generality of conclusions (2) and (4) could be tested by further research in the United States, bearing in mind the necessity for an array of tests when awareness levels are being investigated.

F. Summary

The development of ethnic awareness in relation to age, degree of skin pigmentation and parental race, was investigated among Maoris, a colored ethnic minority in New Zealand. Seven tests of ethnic awareness, previously used with a pakeha (white) sample, were administered to 180 Maori *S*s in the age range from 4 to 12 years. It was found that ethnic awareness increases with age, and that the variables of skin pigmentation and parental race are significantly related to performance on tests that involve an identification process. Majority-minority group differences in awareness are limited to performance, on tests of identification. Further research in awareness development is needed. Results cannot be generalized until a wider range of awareness tests is employed.

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"FIXATION" IN THE RAT AS A FUNCTION OF INFANTILE SHOCKING, HANDLING, AND GENTLING*[1]

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A. INTRODUCTION

In the light of common sense and clinical lore, both of which assume the conditioning theory of anxiety, it is disconcerting to find infantile encounters with presumably painful electric shock, with presumably neutral handling, and with presumably pleasurable gentling associated with similar effects on adult behavior and on development. It is especially disconcerting to find all three of these kinds of infantile encounters associated with decreased "emotionality." [See Denenberg (11); Denenberg and Karas (16); Denenberg, Morton, Kline, and Grota (18); Levine (46, 47, 49, 51); Ruegamer, Bernstein, and Benjamin (70); Smith (75); Tedeschi and Harburg (78).] Perhaps the data to be presented in this article will be disconcerting only for those who, anthropomorphically, assume that "emotionality" is exhibited (*a*) in defecation and urination in, (*b*) in time taken to enter—(timidity), (*c*) in amount of activity in, or (*d*) freedom to consume food or water in an unfamiliar situation which, typically, consists of some version of Hall's open field (32). It is almost equally disconcerting to find that all three of these kinds of infantile experience are associated with increases in later ability to learn [Brookshire (5); Brookshire, Littman, and Stewart (6); Denenberg (11); Denenberg and Bell (14); Denenberg and Karas (16); Karas and Denenberg (43); Levine (46, 50); Levine, Chevalier and Korchin (55)]. In this connection, ability to learn has usually been assessed as the number of trials required to develop a response that avoids painful stimulation. Such

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[1] This paper is based on a thesis submitted to the University of Illinois in partial fulfillment of the requirements for the doctorate in psychology.

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[3] This paper was prepared while Dr. Hunt was supported by USPHS Grant MH K6 18567. The theoretical formulations and predictions are primarily his, but it was Dr. Salama who first conceived the idea of using Farber's "fixation" measure (20) to assess the effects of infantile experience.

findings have not been obtained by all investigators [e.g., Ader (1), Gertz (25), McMichael (61), Scott (73), Tapp and Markowitz (77)], but they have turned up often enough to be of impressive validity. It is also puzzling, if true, to find these various kinds of infantile encounters associated with increases in the rate of development. Rats gentled for a number of days following weaning have been found to be heavier than unmolested controls. [See Bernstein (3); Elrick and Bernstein (19), Greenman and Duhring (28), McClelland (60), Mogenson, McMurray, and Jacques (65), and Weininger (80, 81). But Ader (1), Levine and Alpert (53), Levine and Otis (54), Mogenson and Ehrlich (64), and Scott (73) have not found this result.] Moreover, Mogenson and Ehrlich (64) and Scott (73) found rats shocked for 21 days after weaning to weigh less than the controls. But both handling [See Levine (47) and Levine and Otis (54)] and shocking [Smith (75)] before weaning have been found associated with heavier later weights than were found in pups left unmolested in the maternal nest. While the effects of shock and gentling after weaning on bodily growth may differ in direction, the data available suggest that encounters with shock, handling, and gentling before weaning may well be interchangeable in their tendency to stimulate growth.

Evidence that enriched variation in infantile experience may increase the rate of maturation comes also from other indicators. Levine (51) has found that mice handled during infancy fight at an earlier age than do controls left unmolested in the maternal nest. Levine, Alpert, and Lewis (56) have found that rats handled daily from birth until they are 12, 14, or 16 days of age and then sacrificed show the level of depletion of adrenal ascorbic acid typical of adult rats; whereas unmolested controls fail to show any depletion until they are at least 16 days of age.

Krech, Rosenzweig, and Bennett (44) have described alterations in the cholinesterase (ChE) distribution in the rat brain associated with the complexity of prior postweaning experience: the more complex the previous experience of the animals, the lower the cortical ChE but the higher the subcortical ChE [see also Rosenzweig, Krech, and Bennett (69)]. In an extension of these studies, Tapp and Markowitz (77) have observed that rats handled during the first 10 days of life have a heavier subcortex with lowered cholinesterase activity than rats left unmolested in the maternal nest. No differences in weights of cortex or of cortical cholinesterase activity appeared. Finally, Meier (62) and Meier and Stuart (63) have reported that Siamese kittens which are stroked for two daily periods of 10 minutes during their first 30 days of life open their eyes earlier, show synchrony of the electroencephalogram earlier, appear outside the nesting boxes earlier, and show a greater degree of the darkened coloration characteristic of mature Siamese cats at the end of their first month of life than do kittens left unmolested in the nests. Whether electric shock would serve to facilitate development in similar fashion is, however, not clear.

Just as important, if perhaps less dissonant with the conditioning theory of anxiety, are the reports of all these forms of early experience being associated with increased capacity and struggle for survival under stress. Several investigators have found such associations [Bernstein (3); Conger, Sawrey, and Turrell (10); Denenberg and Karas (15); Griffiths (29); Levine (48); Levine and Otis (54); Ruegamer *et al.* (70); and Weininger (80, 81)], but some others have not [e.g., Ader (1), Goldman (27), McMichael (61), Scott (73)].

Such evidence has led Levine (51) to contend that it is stimulation *per se* regardless of its nature, that counts in infancy, and the prevalence of this belief appears to be growing. On the other hand, Brookshire, Littman, and Stewart (6) have contended that infantile stimulation may have a variety of residua that vary with the kind of stimulation, with the age at which it is encountered, and with the adult behavior measured.

All this evidence is hard on the conditioning theory of anxiety so widely assumed, after Freud relinquished his earlier notion of anxiety as repressed libido (38, p. 298), to supply the only source of anxiety and to describe the inevitable effect of encountering painful stimulation. Since World War II, however, the universality of this theory has lost much of its force. First, Hebb's discovery of fear of "the familiar in an unfamiliar guise" (33) has shown that fears of innocuous objects can have a basis other than that of having been previously associated with painful stimulation. Moreover, Hebb's neuropsychological theorizing (35) suggests that encountering a variety of receptor inputs during infancy may help to innoculate a young animal against fear of the unfamiliar and the strange. Second, Helson's theorizing about and work on the adaptation level (37), which theorizing and work make new and broad theoretical use of the long-known phenomenon of sensory adaptation, implies that any modality of stimulation repeatedly encountered tends to lose some of its special character as it gradually becomes typical or "average." This notion would apply to the painfulness of strong stimulation. Thus, contrary to the fearful sensitizing assumed (from conditioning theory) to be inevitable, repeated encounters with painful stimulation might be expected to reduce its aversiveness and its instigative potency. This may happen under many, but perhaps not under all conditions, for aversive conditioning is a fact. Traumatization is also a fact. Thus, this line of thought does not say that fear is never conditioned, or even that it is not often conditioned. It says that fears and anxiety may have sources other than association with painful stimulation, and that encounters with painful stimulation may have effects other than anxiousness and the sensitization of an organism. The conditions under which these variations occur are not yet clearly specifiable.

These two still unfamiliar conceptions may help us to understand some of the puzzling effects of infantile experience. Their implications need to be separated and made explicit. According to the Hebbian notion, the encountering of a variety of stimulation during infancy ("primary learning") may be expected to facilitate the development of those autonomous central processes that are conceived to mediate an organism's capacity to profit from later experience ("later learning"). In the studies of the effects of "restricting" and "enriching" infantile environments on adult problem-solving, considerable evidence has accumulated to support such a proposition. In the first such study, Hebb (34) found that, on the Hebb-Williams maze-test of animal intelligence (36), the learning ability of pet-reared rats was superior to that of cage-reared rats. Supportive evidence for the rat has come from studies by Bingham and Griffiths (4), Forgays and Forgays (21), Forgus (22, 23, 24), Hymovitch (41), and Luchins and Forgus (59). Supportive evidence for the dog has come from studies by Clarke *et al.* (9) and by Thompson and Heron (79); and the superiority of the pet-reared animals over those cage reared appears to be substantially greater for the dog than for the rat. In the result just mentioned, there is a hint that the degree of effect of infantile experience may increase up the phylogenetic scale as the ratio of associative structures to direct sensory and motor structures [A/S ratio as conceived by Hebb (35)] increases. It may be that "emotionality" in part is a special case of capacity to profit by experience. Capacity and struggle for survival under stress seem to be much less clearly related; they well may have a different organismic basis.

From the standpoint of the notion that "emotionality" is capacity to profit by experience, electric shock might be expected to have effects similar to those of handling, gentling, shaking [Levine (51)], or temperature change [Schaefer, Weingarten, and Towne (71)]. So long as comparisons are limited to the effects of encountering any one such form of stimulation with the effects of remaining unmolested in the maternal nest-cage, each encounter may be seen chiefly as an enrichment of the variety of stimulation. Thus, the effects of such forms of infant stimulation might be expected to be similar. Moreover, if the encounters with such stimuli are made to occur so early in life that the infant organism can hardly have developed autonomous central processes mediating the "interpretation" of such inputs, the effects on capacity to learn, on "emotionality," and on development could hardly fail to be similar.

On the other hand, according to Helson's adaptation-level theory, the effects of the various forms of stimulation should differ. Encounters with painful stimuli (and such encounters alone) should reduce the aversiveness of later encounters with such stimuli. Gentling, insofar as it is truly a pleasurable experience for the infant animal, might be expected to increase, rather than to decrease, the aversiveness and the instigative potency of later encounters with painful stimuli.

It is conceivable, however, that the Hebbian effect of varied stimulation on autonomous central processes and the Helsonian adaptation to various categories of inputs might go on independently. If they do, it would be expected that encounters with painful shock should share with handling and gentling the capacity to decrease "emotionality," to increase learning ability, to foster a more rapid rate of development, and perhaps to increase capacity and struggle for survival. It would also be expected that encounters with painful stimulation should decrease the later aversiveness of such stimulation. [See Goldman (27), Griffiths (30), and Steckle and O'Kelly (76).] In the light of such conceptualizing, it is conceivable that infantile encounters with electric shocks would serve both (*a*) to facilitate the later acquisition of avoidance conditioning and (*b*) to decrease the aversiveness and instigative potency of later encounters with shock.

B. METHOD

Getting evidence relevant to the combination of hypothetical expectations just mentioned requires a situation in which "emotionality" and learning ability are involved simultaneously, with some indication of the aversiveness or the impact of painful stimulation. Such a situation appears to exist in Farber's "fixation" procedure (20) and by his finding that the administration of shock immediately following the choice point—as rats run to one of the goal boxes for food in a T-maze—makes running to that gold box more resistant to change when food is later omitted there and put *only* in the previously incorrect goal box. Because the T-maze is an unfamiliar situation when an animal is first introduced into it, it affords measures of the customary indicators of "emotionality": amount of defecation and urination, time required to enter the maze and to get to the goal box the first time (timidity), and the number of trips from starting box to goal box and return (activity). It also affords measures of learning ability. These are the errors made during reward learning to go to the "correct" goal box consistently, and the number of shocks in the stem of the maze required to motivate the animals past the choice point during the trials on which they get shock there.

Farber (20) found a marked difference in this measure of "fixation" between rats from two colonies: one in the psychology laboratory and the other in the anatomy laboratory. He attributed the difference to genetic constitution. But, perhaps, in the light of Christie's concern (7, 8) with the variations in early experience which rats get in colonies with diverse rearing practices, infantile experience might also alter the degree to which shock at the choice point "fixates" going to the box concerned. From adaptation-level theory, one would expect infantile encounters with electric shock to decrease the degree to which shock after the choice point will "fixate" the choice of goal box; while gentling might increase it.

1. *Strategy of the Experiment*

The foregoing considerations determined the strategy of the experiment. This strategy consisted of varying the kinds of circumstances encountered by groups of rat pups during their second 10 days of life and then of comparing at adulthood the various performances of the groups in the T-maze. A total of 100 male rats were divided into five groups of 20 for each of five conditions. Because a group of 100 rats was too large to manage at once, the experiment was run in four replications of five social-litter groups of five rats each. Of the five groups, two groups (CC and CS) were controls, both left unmolested in the maternal nest until weaning at 28 days; three groups were experimental. Of the latter three groups, the pups in one group (shocked—S) were removed from the maternal nest onto an electrified grid with shock strong enough to keep them squealing continually throughout the three-minute period; the pups in a second group (handled—H) were removed from the nest to the cold grid and left unmolested for the three minutes, and the pups of the third group (gentled—G) were removed from the nest to the cold grid and there stroked continuously by hand for the three minutes. All groups were then left unmolested until weaning on Day 28, when they were individually caged with continuous supplies of food and water until the time for the various adult tests; those already indicated, as well as time of swimming for survival in ice water.

Table 1 gives a synopsis of the schedule of procedures.

2. *Subjects*

The 100 male rats used as subjects were of the Abrams Wistar strain. They were bred and reared under *E*'s supervision in a special colony at the

TABLE 1
Schedule of Procedures and Measures Employed in Each Replication

Day	Procedure
1-2	Five largest male rats in each of five litters born within 40 hours are weighed and divided into sociological litters, with one pup of each biological litter to each mother.
3-10	All litters unmolested. Food and water *ad lib.*
11-20	Infantile procedures begin: shocked group (S) removed and shocked on grid for three minutes each day; handled group (H) removed from nest and placed on cold grid for three minutes; gentled group (G) removed to grid and stroked by hand for three minutes; control-control (CC) and control-shock (CS) groups left unmolested in maternal nest.
21-27	Infantile procedures cease. All pups remain unmolested in maternal nests for seven days.
28	Weaning. Pups from each group weighed and caged individually with food and water *ad lib.*
29-50	Individually caged pups undisturbed.
51	Adult measures begin. Each rat weighed and introduced into starting box of unfamiliar, grid-floored T-maze with access to whole maze for 10 minutes. Measures include: presence or absence of defecation and urination; time to leave SB and get to GB (timidity); presence or absence of eating in GB; number of SB-GB trips (activity). Food removed from home cages to start feeding schedule.
52	Repeat measures in T-maze after rats have been 24 hours without food. Begin schedule of three-hour daily feeding after each set of adult procedures.
53	Hungry rats introduced for three minutes into each GB of T-maze with food available.
54	Hungry rats given four forced trials in T-maze with food reinforcement. Nos. 1 and 3 to right GB; Nos. 2 and 4 to left GB.
55-58	Preshock learning. Ten trials a day. First trial on first day was choice-free, and choice determined correct GB. No reward on incorrect GB; retracing prevented.
59-63	Shock training for all groups but CC. Shock first of 55 microamps administered as animal entering GB; shock finally of 140 microamps administered immediately after choice-point. Ten trials a day; 10 minutes between trials.
64-67	Extinction series begins. Each animal weighed. Food shifted from correct GB to incorrect one. No shock. Ten trials a day; 10 minutes between trials. Criterion: two successive reversals. Score: number of trials required for two successive reversals.
68-71	For those failing to change GB, 10 massed trials a day; two minutes between trials.
72	Survival test.

Galesburg State Research Hospital. In order to have manageable numbers, they were selected in four installments of 25 each. Each installment came from five litters born within a 48-hour period. Once the litters were available, the five largest males in each litter were selected. To minimize genetic differences, social litters were formd by giving to each mother one pup from each of the other mothers. When the social litters were formed, they were randomly assigned to the five experimental conditions (CC, CS, S, H, and G).

One consequence of conducting the experiment with four replications of such installments was the fact that the rats were born and reared under seasonal variations that ranged from summer to winter. While the animals were exposed to minimal extraneous noise, the temperature varied from 68° to 94° F, as recorded by a maximum-minimum recording thermometer.

3. *Apparatus*

The pups were reared in unusually large nest cages (dimensions: 9″ × 18″ × 50″) of stainless steel. The infantile treatments were administered in a set of four rectangular wooden compartments (4″ × 9″ × 9″) with grid floors of nickle-silver rods separated by 5/16 of an inch. The shock source was a stimulator that consisted mainly of a power transformer that delivered 260 V.A.C. on the secondary; of two fixed resistors, wired in parallel, to offer resistance totaling 218,000 ohms; and of a variable potentiometer (250,000 ohm capacity) calibrated in microamps within the range of 50 to 200 microamps. This stimulator was used to activate the grids to shock the infant rats and to electrify the three grids in the T-maze.

The T-maze, modeled after but not identical with that made by Farber (20), was constructed of unpainted 3/8 inch plywood. The sides were 3.5 inches high, and the floor plan was the same as that used by Farber. The starting box (SB), the goal boxes (GB), and the stem of the maze had roofs of colorless plexiglas, but the choice point and the two arms were covered by .25 inch wire mesh. All doors were of plexiglas painted to resemble the unpainted plywood, and they were operated vertically, by the experimenter (*E*), through an ordinary mirror placed beneath the apparatus. Inasmuch as the floors of the stem and of each of the arms consisted of nickle-silver rods separated by 5/16 inch, the progress of an animal could be observed in the mirror under the floor. The rods flooring the stem and those flooring each of the arms were so wired as to form three independently electrifiable grids. The floors and walls of the left GB were covered with fine wire mesh; whereas those of the right GB were covered with cork matting, to increase discriminability. Black cloth curtains were put behind the doors to the GBs; they prevented the rats from seeing (in anticipation) whether or not food was present. Three photoelectric cells were mounted on the walls of the maze. One was attached to the side walls of the stem of the maze on the stem-side of the door that separated stem from starting box. When this beam across the stem was broken, it started a standard electric timer and produced a click that, at first, elicited startle reactions from the animals. The second and third cells were installed on the side walls of the two arms directly before the doors that led to the goal boxes. Interruption of either beam stopped the timer. Thus, the time taken by a rat to run between SB and GB could be measured fairly accurately. A metal tray 2.5 inches wide served as a container for the food reward, which consisted of moistened balls of white bread each of which was approximately one gram in weight. This T-maze served as the unfamiliar place in which the indicators of "emotionality" were observed, as the place in which learning ability was assessed, as the place in which goal-box choice was "fixated," and as the place in which degree of "fixation" was measured.

The apparatus for the swimming-for-survival test consisted of a battery jar 9″ in diameter and 12″ high and of a ball jar 6.5″ in diameter and 12.5″ high. The battery jar was filled with water, and the inverted bell jar was balanced on three supports along the wall of the battery jar. This arrangement provided an air space—4.25″ high above the water in the battery jar—where the rat, by keeping its nose above the surface of the water by swimming or floating, could breathe. At the time of the survival tests, on Day 72 following birth, these jars were filled with water of a temperature between 15° and 17° C. A rat was dropped into the filled battery jar, and the bell jar was put into the battery jar. Ice water was added periodically to keep the temperature below 17° C. The time elapsing between placement of a rat in the water and the moment it succumbed was the measure.

4. *Infantile Procedures*

After the division of each installment of five litters, the social litters were caged. The two control litters went unmolested continually until weaning at Day 28; so completely unmolested, in fact, that even cleaning the cages was avoided. All litters were unmolested through the tenth day. The infantile procedures began on Day 11 and continued through Day 20. This period of the second 10 days of life was chosen for the infant stimulation because both Denenberg and Karas (16) and Lindholm (57) found that the effects of shock experience on later behavior are most marked when it comes during the second 10 days of life. Each pup in the shocked groups (S) was removed daily for three minutes from the nest to one of the electrified grids where the shock was repeatedly increased from about 60 microamps upward sufficient to keep the pup squealing continually. Each pup in the handled groups (H) was removed daily for three minutes from the nest to the grid, but these pups were not shocked. Only the loose skin on the neck or back was touched, and the pup was not molested while on the grid. Each pup in the gentled groups (G) was also removed daily for three minutes from the nest to the unelectrified grid, but was carried in the palm of the hand and petted. Once on the grid, moreover, the pup was stroked by hand at the rate of about 50 strokes a minute until returned to the nest.

After a week without molestation in the maternal nests, Days 21 to 27, came weaning on Day 28. All pups in all groups were separated from their mothers, were weighed for the second time, and then were caged individually with a continuous supply of food and water. A colleague coded the animals and caged them so that *E* might no longer know which animal had had each of the infantile treatments.[4] From Day 28 through Day 50, all pups remained undisturbed in their individual cages.

5. *Procedures for Measuring Adult Behavior*

The measurements of adult behavior began on Day 51. On that day, the animals were weighed and were introduced into the T-maze for the first time. As indicated earlier, the measuring procedures included indices of "emotionality," learning ability, and "fixation." Further, each animal was weighed at birth, at weaning, on Day 51, and on Day 64 after two weeks on a schedule of one feeding a day. Finally, came the measure of swimming for survival.

a. "Emotionality." On Day 51, prior to which the rats had had food continuously available, each rat was placed for the first time in its life in the SB of the T-maze. All doors were open, except the one separating the SB from the stem of the maze. A single ball of wet bread was available in the container of each GB. As soon as the rat, in the SB, oriented itself toward the stem of the maze, the SB door was raised, and the animal was allowed 10 minutes of free exploration.

The indices of "emotionality" were as follows: (*a*) The experimenter used a stop watch to measure the time that elapsed between raising the SB door and the moment that the animal got its four feet past the curtain into either one of the GBs. This time has been used as an index of "timidity," i.e., the longer the time the greater the timidity. (*b*) *E* counted the number of entries into each GB. Because the animals nearly always returned to the SB after entering either GB, this count served as a reasonably accurate index of activity. (*c*) *E* also recorded whether or not each rat urinated during the total period of being picked up from its cage and weighed, of being in the T-maze, and of being returned to its living cage. (*d*) *E* recorded whether or not each rat defecated during this same total period.

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[4] We are grateful to Dr. Dennis Kamano for his interest in this experiment and for his untiring assistance to Dr. Salama in its conduct.

When the animal was returned to its individual living cage on Day 51, food was removed.

On Day 52, after the animals had been without food for 24 hours, they were again placed in the SB of the T-maze and these same indices of "emotionality" were again recorded.

When the rats were returned to their individual cages after this second exposure to the T-maze, they were allowed pellets of chow for about three hours; then all food was again removed. This daily schedule of one three-hour feeding of dry pellets was followed for two weeks, until Day 64.

b. Learning. On Day 53, after 21 hours without food, each rat was placed for three minutes in each of the GBs of the T-maze, with food available in the container. This was done to insure that each rat encountered food in both of the GBs and also to habituate the rat to the consuming of food while the GB door was closed. Following this, each rat was given eight running trials with food available in both GBs, so that any GB entry was rewarded. During this procedure, the rat was allowed to stay in the GB for 30 seconds. Then it was returned to its home cage. An intertrial interval of approximately 10 minutes was maintained. On Day 54, each rat got four forced trials reinforced; two trials (the first and the third) to the right GB, and two trials (the second and the fourth) to the left GB. In these trials the door that separated the choice point from the opposite arm of the maze was closed.

"Reward training" began on Day 55. Each rat, after approximately 21 hours without food, was placed in the SB of the T-maze. On the first trial, food was available in both GBs. The box chosen became the "correct" one, and food was not available henceforth in the other box. On each trial, the rat was again allowed to remain 30 seconds in the GB entered. Retracing was prevented by closing the GB door behind him. Upon removal from the GB, the rat was returned to its home cage. Ten trials were given per day, with an intertrial interval of approximately 10 minutes during each of which the animal was in its home cage. The measure of "reward learning" was the number of errors: i.e., the number of times each rat entered the "incorrect" GB during the four-day total of 40 trials.

"Shock training" began on Day 59. During this procedure, the rats in the control-control group (CC) continued with "reward training." Those in the other groups continued to find food on the same ("correct") side, but they got shocked through the grid floors of the arms of the T-maze. At first, this shock was administered as the rat was about to enter the GB; then it was administered closer and closer to the choice point. The intensity of the shock was 55 microamps for the first five trials on Day 59, it was 60 microamps for the second five trials, then 70, and then 80, microamps on Day 60, and on Day 90. Then it was 100 microamps on Day 61; it was 110 and 120 on Day 62; and, finally, it was 140 microamps for all 10 trials of Day 63. The shock came in the "correct" arm and also in the "incorrect" arm whenever a rat made such an error.

After encountering shock in the arms of the T-maze, the rats refused to leave the SB and to run through the stem of the maze past the choice point. Consequently, they were pushed from the SB with a movable end wall that forced them into the stem. In order to prevent the rats from stalling in the stem, shocks of the same intensity as that used on the arm-grids were administered in the stem. Time criteria were employed to determine whether or not to push the rat from the SB and whether or not to shock him when in the stem. On Day 59, the free time was six seconds; on Day 60, it was four seconds; and on Days 61, 62, and 63, it was two seconds. In this situation, the number of shocks that an animal received when in the stem constituted a kind of error score for the "shock training." Again, in "shock training" there were 10 trials a day with an intertrial interval of approximately 10 minutes.

c. "Fixation scores." Beginning on Day 64, the food reward was removed from what had been the "correct" GB throughout training and, henceforth, was put only in the previously "incorrect" GB. Shock was eliminated entirely. For four days, each rat was given 10 trials a day with the usual 10-minute intertrial interval. These trials continued until the rat had achieved a criterion of going twice successively to the previously "incorrect" GB. When a rat failed to achieve the criterion in the four-day total of 40 such trials, it was submitted to a condition of "massed extinction" during which it was given 10 daily trials with an intertrial interval of only two minutes. In no case was this required for more than four days (i.e., Days 67 to 71). Here, the measure of "fixation" was the number of unrewarded trials required to get the animal to give up the previously "correct" GB and go to the "incorrect" one.

d. Survival test. On Day 72, the rat was subjected to the survival test.

C. RESULTS

Fortunately, a preponderant majority of the rats selected for the four replicative installments of this experiment survived, but a few died before weaning. Moreover, one refused to pass the choice point in the T-maze during "reward learning" and had to be eliminated from the later adult tests. The numbers surviving appear in Table 2.

TABLE 2
NUMBERS OF RATS IN THE FOUR INSTALLMENTS SURVIVING TO THE ADULT TESTS

Replications	Groups CC	CS	S	H	G	Subtotal replications
1	5	5	3	5	5	23
2	5	5*	5	5	5	25
3	5	5	5	5	4	24
4	3	4	5	4	4	20
Subtotals	18	19	18	19	18	92

* Includes the rat that refused to pass the choice point in "reward learning."

The results most relevant to the main hypotheses are the errors in learning, the indices of "emotionality," and the measures of the degress of "fixation."

1. *Errors in Learning*

The means of errors in learning for both "reward learning" and "shock learning" appear in Table 3. As expected, the rats which were stimulated in

TABLE 3
MEANS OF ERRORS IN "REWARD LEARNING" AND "SHOCK LEARNING"

Replications	Groups CC	CS	S	H	G	Replication means
	Part A. Means of Errors in "Reward Learning"					
1	2.0	3.0	2.3	1.6	2.0	2.17
2	1.2	2.0[a]	2.8	2.4	4.6	2.52
3	1.8	2.2	2.4	1.8	1.5	1.96
4	9.5	5.3	3.2	3.5	2.3	4.62
	Group means (all replications)					
	3.32	3.05	2.72	2.26	2.67	2.80

Part B. Means of Errors in "Reward Learning" for Combined Groups

Replications	Unmolested	Stimulated	
1	2.50	1.91	2.17
2	1.55[a]	3.27	2.62
3	2.00	1.93	1.96
4	7.38	3.00	4.62
	Group means (all replications)		
	3.19	2.55	2.80

Part C. Mean Numbers of Stem Shocks during "Shock Learning"

Replications	CC	CS	S	H	G	
1	—	3.4	6.0	3.8	3.4	3.09
2	—	2.0	0.8	1.0	1.1	.92
3	—	2.0	3.6	2.6	3.0	2.21
4	—	5.3	5.2	4.8	6.3	4.33
		Group means (all replications)				
		3.11	3.67	2.95	3.28	3.25

[a] Omits one animal that failed to go beyond choice point in T-maze during pre-shock learning.

infancy averaged fewer errors than those left unmolested in the maternal nest (2.55 versus 3.19). The difference, however, falls short of statistical significance ($F = .69$, $df = 4$ and 72). Only the variance among the replications is significant ($F = 5.566$, $df = 3$ and 72, $p < .01$).[5]

The means of the errors in "shock training," defined as the numbers of shocks administered in the stem of the maze to get the rats to pass the choice point, vary negligibly among the experimental groups ($F = .66$, $df = 3$ and 57), but, for some reason not entirely clear, they vary markedly among the replications ($F = 17.32$, $df = 3$ and 57, $p < .001$). The hypothesis that such infantile stimulation increases later capacity for learning fails to get support from these particular error scores.

2. *"Emotionality" Indices*

Some of the results from the indices of "emotionality" confirm the results reported by other investigators and some do not, but the hypothesis that infantile stimulation increases capacity to profit from later experience gets some suggestive *post hoc* support from these results.

a. Defecation and urination. On Day 51, when the rats were first exposed to the T-maze, fewer of the rats stimulated in infancy defecated or urinated than of the rats left unmolested. The numbers of animals which defecated (Part A) or urinated (Part B) in each group for each replication appear in Table 4. It is clear that, in three of the four replications, substantially more of the rats left unmolested in the nest defecated than did those stimulated; and in the fourth replication, no unmolested rat defecated. In all four replications, it is clear that more of the unmolested rats urinated than did those stimulated. The differences are highly significant. When applied to the variance among the groups for defecation alone, χ^2 was found to be 27.504 ($p < .001$), for urination alone it was 34.158 ($p < .001$), and for defecation or urination combined it was 49.398 ($p < .001$). It is clear that stimulation in infancy reduces later "emotionality," when "emotionality" is indicated by the tendency to defecate or urinate in an unfamiliar situation. Moreover, it is clear that rats shocked in infancy differ in the same direction from rats unmolested as do rats handled and gentled.

As indicators of "emotionality," defecation and urination were meaningless

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[5] Although these error scores lacked homogeneity of variance, a parametric analysis of variance appeared to be justified as a test of significance in view of the results of the Norton study [see Lindquist (58)]. Moreover, when they were reduced to ranks, a Kruskal-Wallis, nonparametric analysis of variance corroborated the level of significance.

TABLE 4
NUMBERS OF ANIMALS IN EACH GROUP THAT DEFECATED OR URINATED ON THE FIRST ENCOUNTER WITH THE T-MAZE

Replications	Unmolested groups		Stimulated groups		
	CC	CS	S	H	G
	Part A. Numbers Defecating				
1	5	2	0	0	0
2	5	5	2	0	2
3	2	3	1	0	0
4	0	0	0	0	0
Total	12	10	3	0	2
	Part B. Numbers Urinating				
1	3	3	0	1	0
2	3	3	2	0	2
3	5	4	2	0	0
4	3	3	1	0	0
Total	14	13	5	1	2

on the second day on which the rats encountered the T-maze, following their first 24 hours without food. None defecated or urinated. But the tendency persisted to Day 59 when "shock training" first began. The CC group got no shock. But of the others, 12 of the 18 rats in the unmolested group (CS), six of the 18 in the shocked group (S), seven of the 19 rats in the handled group (H), and five of the 18 rats in the gentled group (G) either defecated or urinated ($\chi^2 = 6.759$, $df = 3$, $.05 < p < .10$). Although this trend falls short of significance, it is interesting because it appears after all the animals had been repeatedly handled as adults for eight days.

b. Timidity. The time required for a rat to leave the starting box (SB) and to enter one of the goal boxes (GBs) was the index used. This index resembled the commonly used index of timidity, but SB-GB time may well be a more stringent test than most others. To enter a GB, the rat had to venture out of the SB into the more-brightly-illuminated stem of the maze and then pass through the black-cloth curtain in the door between the arm and the GB. It is hard to see how this experience would account for the finding that these stimulated rats took substantially longer (on the average) to make their first entry into a GB than those left unmolested in the maternal nest. See Table 5, Part A (1). For this first encounter with the T-maze, this variance among the treatment groups is highly significant. See Table 5, Part A (2). It is also of interest to note that the gentled group (G) took less time on the average to enter a GB than did either the shocked group (S)—$t = 1.69$, $p < .05$—or the handled group (H)—not significant. Finding rats stimulated in infancy showing evidence of greater timidity than rats left unmolested runs counter to all the significant evidence known to the authors. Fi-

TABLE 5

TIMIDITY: MEANS OF SB-GB TIMES IN SECONDS WITH ANALYSES OF VARIANCE AND COVARIANCE

Part A. For First Encounter with the T-Maze

(1) Means of Times in Seconds

Replications	Groups CC	CS	S	H	G	Replication means
1	130.6	158.0	290.3	186.0	150.4	173.74
2	30.2	166.2	80.4	27.2	235.6	107.92
3	22.4	48.8	407.2	724.0	197.5	286.42
4	24.0	97.8	394.4	129.5	68.5	340.10
Group means	54.89	171.39	293.39	273.89	166.11	192.64

(2) Analysis of Variance of Reciprocals of SB-GB Times[a]

Source	Sums of squares	*df*	Mean square	*F*
Treatments	.011060	4	.002765	5.47***
Replications	.008370	3	.002790	5.52***
T × R	.009978	12	.008315	16.45***
Error	.036390	72	.000505	

Part B. For Second Encounter with the T-Maze

(1) Means of Times in Seconds

Replications	Groups CC	CS	S	H	G	Replication means
1	42.0	17.8	31.0	11.8	14.2	22.69
2	39.6	49.2	11.0	9.6	73.4	36.56
3	14.8	24.2	23.2	270.0	11.3	89.84
4	14.3	27.0	48.6	14.5	35.5	29.70
Group means	29.17	29.64	28.22	79.73	34.72	40.62

(2) Analysis of Variance of Reciprocals of SB-GB Times[a]

Source	Sums of squares	*df*	Mean square	*F*
Treatments	.002669	4	.0006725	.22
Replications	.009204	3	.0030680	1.01
T × R	.041170	12	.0034310	1.13
Error	.217830	72	.0030250	

Part C. Analysis of Covariance of Reciprocals of Times for Second Encounter Adjusted for Reciprocals of Times for the First Encounter

Source	Adjusted sums of squares	*df*	Mean square	*F*
Treatments	.005128	4	.001282	.44
Replications	.006445	3	.002148	.74
T × R	.026490	12	.002207	.76
Error	.203968	71	.002872	

*** $p < .001$.

[a] Because time-scores are so extremely skewed, these were converted to reciprocals for the tests of significance.

nally, the fact that the variance among the replications is highly significant and the fact that the treatment-replication interaction, also, is significant suggests that some uncontrolled factor of importance for this measure is associated with the replications. The fact that the replications came at various seasons of the year suggests variations in temperature as a likely possibility.

On the second encounter with the T-maze, the SB-GB times were markedly reduced for all groups. See Table 5, Part B (1). While the unmolested controls remained slightly the faster, the variance among the treatment groups became less than would be expected from random sampling. See Table 5, Part B (2). It is interesting to note also that the order among the stimulated groups changes, with the S group becoming the fastest and the H group, the slowest.

A comparison of the means in Part A (1) and in Part B (1) of Table 5 reveals that the SB-GB times for the second encounter with the T-maze dropped more for the stimulated animals than they did for the controls. Averaging the individual decreases yields a mean decrease of 202 seconds for the stimulated rats and one of 59 seconds for the controls. Insofar as the SB-GB times are indices of timidity, this finding suggests that the impact of one encounter with the maze is greater for the stimulated rats than for the controls. Such suggestion lends support to the hypothesis that infantile stimulation increases the capacity of an organism to "profit from experience."

To an unknown degree, the decreases in SB-GB times are artifacts of the notorious skewness of time scores. When the decreases are partially normalized by a transformation to reciprocals, and the variance of the reciprocals for the second encounter is analysed with a covariance adjustment for the reciprocals of the times for the first encounter, the variance among the groups fails to reach significance (see Table 5, Part C).[6] But perhaps the decreases are not entirely artifactual; perhaps the variance among the SB-GB times hides a real effect for, among the 55 rats stimulated in infancy, only two rats showed increases instead of decreases in SB-GB times between the first and second encounters with the maze; while among the 37 unmolested rats, eight rats showed increases. If an increase in SB-GB time means an increase in timidity, the fact that the difference between only 3.63 per cent of stimulated animals and 21.63 per cent of unmolested animals is statistically significant ($\chi^2 = 7.38$, $p < .01$) suggests that infantile stimulation makes animals more prone to become less timid after one encounter with a situation. The fact that the S group shifts from slowest to fastest, and the G group becomes second fastest, with the H group slowest also suggests that speed of recovery from timidity may be a function of the intensity of infantile stimulation.

c. Activity. Activity in an open field has been used ever since Hall (32) suggested the measure as an index of emotionality. Counting the number of times during 10 minutes that a rat enters a GB in a T-maze is an imperfect measure of activity. Each count contains within it a reflection of the time that a rat took for its first entry into a GB, so the activity score is contaminated with the timidity score. It was anticipated that this contamination would be minor, but with the inordinately long times required to go from SB to GB, it turns out to be a major type of contamination. The results appear in Table 6.

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[6] Mr. Steven Fishkin of the University of Colorado performed these analyses for Table 5 and for Table 6.

TABLE 6
ACTIVITY: MEANS OF NUMBERS OF GB ENTRIES WITH ANALYSES OF VARIANCE AND COVARIANCE

Part A. For First Encounter with the T-Maze

(1) Means for the Various Groups

Replications	CC	CS	Groups S	H	G	Replication means
1	7.4	7.0	6.3	6.6	7.0	6.91
2	8.6	7.2	10.0	9.8	5.4	8.20
3	11.2	6.8	4.2	1.8	5.8	5.95
4	9.3	10.5	5.0	12.0	9.3	9.00
Group means	9.11	7.74	6.38	7.32	6.78	7.37

(2) Analysis of Variance

Source	Sums of squares	*df*	Mean square	*F*
Treatments	80.04	4	20.01	.77
Replications	140.97	3	46.99	1.82
T × R	329.25	12	27.44	1.06
Error	1,859.44	72	25.83	

Part B. For Second Encounter with the T-Maze

(1) Means for the Various Groups

Replications	CC	CS	Groups S	H	G	Replication means
1	7.0	10.4	17.7	11.4	13.0	11.35
2	7.6	8.2	10.0	12.0	9.6	9.48
3	10.8	8.8	13.0	4.4	14.5	10.12
4	16.3	10.5	13.2	13.8	12.5	13.10
Group means	9.77	9.42	13.00	10.21	12.28	10.90

(2) Analysis of Variance

Source	Sums of squares	*df*	Mean square	*F*
Treatments	193.54	4	48.39	2.92*
Replications	189.92	3	63.31	3.82**
T × R	491.67	12	40.97	2.47
Error	1,194.28	72	16.59	

Part C. Analysis of Covariance of Numbers of GB Entries on Second Encounter Adjusted for Entries on First Encounter

Source	Adjusted sums of squares	*df*	Mean square	*F*
Treatments	241.97	4	60.49	4.00**
Replications	162.88	3	54.29	3.59*
T × R	433.76	12	36.15	2.39*
Error	1,071.75	71	15.10	

* $.01 < p < .05$.
** $.001 < p < .01$.

As may be seen from Part A (1) in Table 6, on the first encounter with the T-maze it is the unmolested control rats which made slightly more entries into a GB, but the variance among the groups is even less than would be expected from random sampling. See Table 6, Part A (2). On the second encounter with the T-maze, however, it is the stimulated groups of rats which become the more active, as indicated by GB entries [see Table 6, Part B (1)] and the variance among the groups shows statistical significance. See Part B (2). The fact that the stimulated groups of rats shifted from being the less active to the more active, from the first to the second encounters, suggests again that they profited more from one encounter with the maze than did the unmolested controls. When the variance in the numbers of GB entries on the second encounter were analysed with a covariance adjustment for number of entries on the first encounter, the variance among the groups proved to be highly significant. Here is solid evidence that the stimulated rats did "profit" more from the first encounter than did the unmolested controls (see Table 6, Part C).

3. *Degrees of "Fixation"*

The variance among the group means of unrewarded trials required to get the rats to give up the "correct" GB in which they had found food and to go to the previously "incorrect" GB twice in succession is highly significant (see Table 7).

TABLE 7

DEGREES OF "FIXATION": THE NUMBERS OF UNREWARDED TRIALS REQUIRED TO BRING ABOUT A CHANGE OF GOAL BOX

Replications	CC	CS	Groups S	H	G	Replication means
	Part A. Means of Unrewarded Trials for Various Groups					
1	3.0	17.2	11.7	15.2	30.4	15.83
2	2.2	30.8	9.4	11.8	24.8	15.80
3	3.2	18.6	13.0	31.6	13.0	16.0
4	2.7	15.0	4.8	10.2	14.3	9.50
	Groups means (all replications)					
	2.78	20.68	9.50	17.58	21.39	14.16

	Part B. Analysis of Variance			
Source	Sums of squares	*df*	Mean square	*F*
Treatments	4,740.11	4	1,185.03	8.66***
Replications	676.35	3	225.45	1.65
Interaction	3,021.18	12	251.76	1.84
Error	9,843.35	72	136.71	

*** $p < .001$.

Comparison of the two control groups confirms Farber's finding (20) that shock after the choice point increases the number of unrewarded trials required to make rats change the goal box to which they go. The group that received shock after the choice point required about seven times as many unrewarded trials as those that received only reward (CS mean = 20.68, CC mean = 2.78).

The highly significant variance among the means of unrewarded trials for those groups of rats that got shock training shows that the infantile experience influences the degree of effect which the shock after the choice point has upon the "fixation" of the response. The means for the shocked and gentled groups (S = 9.50, G = 21.29) actually do differ in opposite directions from the mean of the control-shock (CS) group—20.68—but it is only the mean for the S group that differs significantly from that of the CS group. When a *t* test for samples of differing variance was applied to the data for each of these pairs of groups, neither the mean for the H group (17.58) nor that for the G group (21.39) differed significantly from that for the CS group (20.68). Further, the means of the H and C groups did not differ significantly from each other, but the means for all of these three groups were significantly larger than that for the S group (9.5), and the latter mean was also significantly larger than that for the CC group (2.78), which group got no shock training. Clearly, encountering electric shock before weaning decreases the degree to which being shocked in adulthood will increase the resistance of a response to change.

4. *Growth and Resistance to Limited Diet*

All three forms of infantile experience appear to have stimulated growth. Shock, and perhaps handling also, diminished the degree of weight loss incurred by two weeks on one feeding a day. As would be expected, the groups did not vary significantly in weight at birth (see Table 8, Part A: 1 and 2). By the time of weaning on Day 28, the H and G groups averaged heavier than the unmolested controls, the S group was lighter. Even though the variance falls short of statistical significance ($F = 2.46$, when .05 requires $F = 2.52$; see Table 8, Part B), it is worth noting that the shocked and gentled pups differ in opposite directions from the unmolested controls.

On Day 51, all the groups that were given infantile stimulation averaged heavier than either group of rats left unmolested, and the variance among the groups is highly significant ($p < .005$; see Table 9). Although the gentled group was still heaviest on the average, it was now the shocked group which was next heaviest. The lightest of the stimulated groups of rats was the group

TABLE 8

GROWTH: MEAN WEIGHTS AT DAYS 1 AND 28, WITH ANALYSES OF VARIANCE

Part A. Day 1

(1) Means of weights

Replications	CC	CS	Groups S	H	G	Replication means
1	8.10	7.38	7.16	7.52	8.14	7.66
2	7.48	7.82	8.50	7.86	7.60	7.85
3	7.54	7.20	7.40	7.02	7.18	7.27
4	7.22	7.10	7.38	7.12	7.16	7.19
Group means	7.58	7.37	7.61	7.38	7.37	7.45

(2) Analysis of Variance

Source	Sums of squares	*df*	Mean square	*F*
Treatment groups	.98	4	.245	.19
Replications	7.39	3	2.463	1.94
Interaction	7.16	12	.596	.47
Error	101.69	80	1.270	

Part B. At Weaning on Day 28

(1) Means of Weights

Replications	CC	CS	Groups S	H	G	Replication means
1	88.0	87.4	84.7	79.0	95.0	80.03
2	58.6	69.4	79.2	64.0	60.0	66.36
3	68.4	70.0	74.0	77.2	74.5	72.75
4	96.7	94.5	89.0	102.8	111.8	98.55
Group means	75.83	74.21	81.39	79.63	84.45	78.41

(2) Analysis of Variance

Source	Sum of squares	*df*	Mean square	*F*
Infant treatments	586.20	4	195.40	2.46
Replications	14,071.39	3	4,690.47	9.05*
Interaction	2,755.29	9	306.14	3.86*
Error	6,036.10	76	79.42	

* $p < .01$.

that was handled that got the least extra stimulation in infancy. This change of position by the shocked group from the lightest to the second heaviest suggests that the stimulated animals may have gained more than their unmolested litter mates. To partial out the variance in weight that existed among the groups at weaning, a two-way analysis of covariance was made, in which the individual weights on Day 51 were adjusted for weights on Day 28. This analysis indicates (see Table 9, Part C) that the rats which got infantile stimulation did gain significantly more than their controls. It indicates further that the effects of the infantile experience endure in operation long after the encounter has ceased.

The weighing on Day 64 came immediately after the animals had been on a single feeding a day for two weeks. This regimen proved to be a reducing

TABLE 9

GROWTH: MEAN WEIGHTS AT DAY 51 WITH ANALYSES OF VARIANCE AND COVARIANCE

			Groups			Replication
Replications	CC	CS	S	H	G	means
			Part A. Means of Weights			
1	246.4	241.8	244.3	235.0	252.4	243.96
2	192.8	201.6	228.6	209.8	193.2	205.20
3	197.2	203.8	207.8	202.0	209.8	203.87
4	209.7	222.0	229.0	239.0	265.0	233.90
Group means	211.72	217.32	225.56	220.53	229.28	219.69

Part B. Analysis of Variance

Source	Sums of squares	*df*	Mean square	*F*
Infant treatments	5,283.31	4	1,761.10	4.198**
Replications	28,880.83	3	9,626.94	22.946***
Interaction	6,266.93	9	696.33	1.659
Error	31,885.15	76	419.54	

Part C. Analysis of Covariance, Adjusted for Weights on Day 28

Source	Adjusted sums of squares	*df*	Mean square	*F*
Infant treatments	2,172.99	3	724.33	2.80*
Replications	8,284.32	3	2,761.44	10.66***
Interaction	1,490.04	9	165.56	.64
Error	19,435.38	75	259.14	

*$p < .05$.
**$p < .01$.
***$p < .001$.

diet for the rats. Scrutiny of Parts A of Tables 9 and 10 shows that all but five of the groups lost weight. The shocked group of rats then became the heaviest of all; the average loss of weight was less than half of that for the group (group H) losing the next least amount of weight (6 grams *vs.* 13.03 for the H group). This change in weight suggested that the infantile experience might be serving to bolster resistance to the restricted feeding, as Levine and Otis (56), and Denenberg and Karas (15), have found. Again, a two-way analysis of covariance was conducted with the weights at Day 64 adjusted for weights on Day 51, and it indicates that, indeed, the variance among the groups in weight loss is significant (see Table 10, Part C). Since the gentled animals suffered a loss as large as the controls, a major share of this variance appears to derive from the resistance to the effects of restricted feeding, of the group shocked in infancy.

Again, the largest single contributor to the variance in rat weight is the replications. In view of the fact that the only factor known not to be controlled was the season of the year, the authors are at a loss to explain the effect of the replications, unless the crucial factor is temperature or some other factor associated with season.

TABLE 10
RESISTANCE TO RESTRICTED FEEDING: MEAN WEIGHTS ON DAY 64, WITH ANALYSIS OF VARIANCE AND ANALYSIS OF COVARIANCE

Part A. Means of Weights after Two Weeks of One Feeding a Day

Replications	CC	CS	Groups S	H	G	Replication means
1	229.6	218.4	237.0	227.0	232.0	228.09
2	171.4	182.3	216.0	198.4	177.2	189.33
3	184.8	188.6	197.2	170.0	194.0	186.62
4	213.3	213.5	234.8	241.3	259.5	233.06
Group means	198.28	201.00	219.50	207.50	214.40	208.02

Part B. Analysis of Variance

Source	Sums of squares	*df*	Mean square	*F*
Treatments	5,715.12	4	1,428.78	2.76*
Replications	41,662.68	3	13,887.56	26.82***
Interaction	9,565.27	12	797.11	1.54
Error	36,765.35	71	517.82	

Part C. Analysis of Covariance, Adjusted for Weights on Day 51

Source	Adjusted sums of squares	*df*	Mean square	*F*
Treatments	1,106.79	4	276.70	3.34*
Replications	3,285.52	3	1,095.17	13.20***
Interaction	2,507.96	12	208.99	2.52**
Error	5,806.50	70	82.95	

* $.05 < p < .01$.
** $.01 < p < .001$.
*** $p < .001$.

5. *Capacity for Survival in Cool Water*

Inasmuch as the stimulated animals lost less weight than their unmolested litter-mate controls, one might expect the stimulated animals also to swim longer for survival, but such is not the case. The means of the times for the various groups to sink and die were as follows: CC mean = 39.26 minutes, CS mean = 27.62 minutes, S mean = 22.12 minutes, H mean = 24.62 minutes, and G mean = 29.95 minutes. It is the unstimulated controls that survived the longest, but when (because of skewness) these data were reduced to ranks and analyzed by the Kruskal-Wallis one-way analysis of variance, the variance among the groups was not statistically significant ($H = 1.066$).

D. DISCUSSION

This study has the merit of having measured a variety of effects of several kinds of infantile experience on the same animals in four replications. Some of the findings clearly agree with those of other investigators, some do not, and some are entirely new. The findings have a number of implications and ramifications.

The fact that all forms of infantile stimulation are associated with decreased defecation and urination in an unfamiliar situation agrees with the results obtained repeatedly by Denenberg and by Levine and their collaborators [see reviews by Denenberg (13) and by Levine (52)]. The finding that rats gentled and handled grow faster and become heavier than unmolested controls agrees with those of many investigators [see Bernstein (3), Elrick and Bernstein (19), Greenman and Duhring (28), McClelland (60), Mogenson *et al.* (65), and Weininger (80, 81)]. The finding that shocked rats, as well as handled and gentled rats, weigh more as adults than do unstimulated controls agrees with results obtained by Levine (47), Levine and Otis (56), and by Smith (75); but the fact that the shocked rats, at weaning, were lighter than the controls, while the gentled rats were the heaviest of all until after the two weeks of restricted feeding corresponds with the findings of McMichael for stimulation before weaning (61) and of Scott for stimulation after weaning (73). The finding that stimulation in infancy, and especially electric shock, decreases the tendency to lose weight under conditions of restricted feeding may agree with the findings of Levine and Otis (56) to the effect that rats handled through weaning had fewer mortalities in the course of 120 hours of food and water deprivation, and of Denenberg and Karas (15) to the effect that rats handled for their first 20 days lived longer on total food and water deprivation than did controls. The fact that the variance among the replications and the interaction of the conditions of the replications with those manipulated experimentally were regularly large and highly significant for such measures as these helps to explain why the findings of various investigators have often failed to agree.

Contrary to the findings of most other investigators, the rats that got extra stimulation in infancy were both more timid and less active during their first encounter with the unfamiliar T-maze than were those that were unmolested in the maternal nest. This result may be a consequence of the nature of the unfamiliar situation (a T-maze rather than an open field), but it is hard to see why this should matter. This experiment also failed to yield evidence, from the errors in "reward learning" and in "shock learning," that the variations in infantile experience result in variations in learning ability. Here, however, it may be seen that the apparatus and the measure could account for the difference in findings. Once the rat has found food in the goal boxes, reward learning in a T-maze probably consists in the rat's overcoming his tendency to alternate. Montgomery (66, 67) has secured evidence to indicate that this alternation is motivated (probably) by avoidance of the boredom of repeatedly encountering the same conditions or by interest in changes of conditions. This is a very different use of experience from that to be found in the avoidance conditioning that Brookshire *et al.* (6), Denenberg (11), and Levine (46, 48) and their collaborators have employed to assess the effects of infantile stimulation. Such a consideration suggests that "learning ability" or the "capacity to profit by experience" is not a unitary factor in factor-analytic terms. Similarly, the fact that infantile experience, and especially that of electric shock, appears to increase capacity to endure feeding restriction without loss of weight—a fact that agrees with findings by Denenberg and by Levine—without increasing capacity to survive longer by swimming in water indicates that capacity to survive is hardly a unitary factor. Finally, whereas most other investigators have found these indicators of "emotionality" moving together as an effect of infantile stimulation, they fail to move together in this experiment. Typically, decreases in defecation and urination go with decreases in timidity and increases in activity. Here the stimulated rats defecated and urinated less in the unfamiliar T-maze than did the unmolested controls, but they took more time, for the first time, to go from the starting box to the goal box, and they were slightly less active, as shown by fewer entries into the goal boxes in the time allowed. Perhaps these various indicators of "emotionality" move together in some situations and not in others.

Completely new, to the best of our knowledge, are the following findings: (*a*) the suggestions that, in changing some behavioral indicators of "emotionality," the impact of a given encounter with the T-maze is greater for the stimulated animals than for animals left unmolested; and (*b*) the fact that infantile experience markedly alters the impact of later encounters with painful stimulation. The facts that the stimulated animals shift from being considerably more timid in the first encounter with the T-maze (longer SB-GB times) to being essentially the same as the unmolested controls and shift from being less active on the first encounter to being more active on the second (than the unmolested controls) suggest that the impact of a given encounter may be greater for the stimulated than for the unmolested animals. If the findings are reproducible, they will lend further support to the proposition that variety in infantile stimulation fosters, at least in certain ways, the capacity of organisms to utilize later experiences.

The finding that infantile experience, and particularly infantile encounters with shock, reduces the degree to which being shocked after the choice point in a T-maze "fixates" the goal-box choice is apparently a highly dependable new fact. Even though the various conditions associated with the replications produced significant variations in most of the measures of this experiment and also interacted significantly with the conditions manipulated experimentally, this is not so for the numbers of unrewarded trials required to bring about a change of goal box. The effect of encountering shock before weaning, moreover, shows up in each replication and is highly significant.

Several theoretical implications may be noted. First, with respect to the main hypotheses under investigation, although the common effect of shocking, handling, and gentling supports Levine's theory (51) that it is stimulation *per se* that counts in infancy, this contention is not consonant with several other facts from this experiment. It is not consonant with the fact that the gentled rats were heavier while the shocked rats were lighter than the controls at weaning. It is not consonant with the fact that the gentled group averaged significantly less time in moving from the starting box to the goal box in the first encounter with the T-maze than did the shocked animals. It is not consonant with the fact that it was the shocked animals that changed most between the first and second exposures to the T-maze in both "timidity" and "activity." And it is not consonant with the fact that it was the shocked animals which showed the least weight loss under restricted feeding while the gentled animals showed nearly as much as the unmolested controls. In this connection it is interesting, that, on Day 51, it was the handled group that was lightest, for this is the group that got the least extra stimulation, *per se*. These findings are consonant with the conception that shocking, handling, and gentling have much in common, and that what they have in common is that which derives from encountering variety in stimulation. But this is not the whole story—even before weaning—for the painful shock stimulation differs from handling and gentling fairly consistently in some of its effects. Only further investigation can clarify these effects, but it would seem likely that the degree of differentiation of effects would increase with the degree of difference along the pain-pleasure continuum and with the age at which extra stimulation is encountered.

Most definite and dependable, however, is the unique effect of encounters with electric shock. Presumably, until demonstrated otherwise, this is an effect of all forms of painful stimulation. As expected from Helson's adaptation-level theory (37), repeated encounters with such stimulation in infancy reduce the impact of later encounters with painful stimulation. In some sense, this finding corroborates those of Goldman (27), and of Griffiths (30) on the intensity of shock required to instigate escape behavior, and of Steckle and O'Kelly (76) on the readiness to endure shock to get to water. But it has broader significance in that the infantile encounter with shock serves to reduce the impact of later encounters with shock on the stability of a habit; i.e., the goal-box choice. This effect also appears to involve resistance to the effects of restricted feeding on weight loss, or is this mediated by a different mechanism?

There are other ramifications less immediately related to our main hypothesis. Schaefer, Weingarten, and Towne (71) have contended that the reduced temperature associated with removal of a pup from the maternal nest may well be *the basic variable* in shocking, handling, and gentling, but this cannot be true for the unique effects of shocking on the impact of later encounters with shock. Levine, Alpert, and Lewis (56) have shown that sharp reductions in temperature before weaning can affect adrenal responsiveness. Presumably such reductions in temperature encountered are involved regularly in all such experiments on infantile experience. Perhaps it is variation in temperature associated with seasons that produces much of the variance among replications in this experiment, and perhaps it is lack of control of temperature that accounts for some of the lack of agreement among the various investigators of the effects of infantile experience. But is that the whole story? Not at all! What seems more likely is that reduction in temperature constitutes another example of stimulus-variation. When comparisons are made between animals which have encountered such changes before weaning with those which have been left unmolested in the maternal nest, reduction in temperature—like handling or shocking—is but one form of variation in stimulation.

Another ramification, apparently unnoted to date, concerns the fact that electric shock after the choice point markedly increases the number of unrewarded trials required to get the animal to give up going to his accustomed goal box for food and to try the other one. Originally noted by Farber (20), this finding is strongly substantiated by this experiment. It should be noted that the number of unrewarded trials required for a change of goal box used to assess "fixation" involves the same operation as that used to measure "resistance to extinction" where the change in behavior is from running to not running. Thus, the conditions of acquisition in the T-maze used should generalize to situations in which resistance to extinction is measured. Ever since Skinner (74) noted and Humphreys (39, 40) called repeated attention to the fact that habits established with intermittent reinforcement require more trials for extinction than do habits established with regular reinforcement, this fact has been a puzzle for interpretation. Amsel (2) has attributed extinction of a habit to the aversive effects of frustrative nonreward. He has attributed the fact that intermittently rewarded habits require more unrewarded trials for extinction than do consistently rewarded habits to the opportunity which encounters with intermittent mixtures of reward and nonreward afford for the frustration of nonreward to become a conditioned stimulus for the anticipation of reward. Mowrer (68, pp. 403 ff.) has elaborated this conception in his theory of counterconditioning which he too has used to explain increased resistance to extinction from intermittent reinforcement during acquisition. He has also used the conception to explain the fact that the interpolation of an occasional punishment among the rewards during acquisition increases the number of unrewarded trials required for extinction (unpublished study by Tsushima) and also Akhtar's finding (also unpublished) that it increases the number of punished trials required for extinction. The fact that shock after the choice point increases the number of unrewarded trials required to change behavior substantiates the point that the effects of painful stimulation will generalize to the presumed aversiveness of frustrative nonreward. The fact that each shock delivered after the choice point is followed very shortly on each trial by food-reward makes this finding consonant with Mowrer's notion of counterconditioning (68). But what of the fact that encountering electric shock in infancy reduces the "fixation" impact of shock after the choice point? Another puzzle to speculate about and to investigate!

Finally, to return to our opening concern, comes the implication of these findings for the conditioning theory of anxiety and fear, a theory widely and implicitly assumed. First, while the consequences of encounters with varied stimulation are not entirely clear, the evidence from this study (coupled with that which has accumulated from other studies) would indicate that such encounters do help to innoculate an organism against the fears of the unfamiliar and the strange. Moreover, even though electric shock is presumably painful, it appears in the main to share, with such other variations of infantile experience as being shaken, being cooled, being handled, and being petted, this effect upon reaction to the unfamiliar, which is quite contrary to any contention that anxiousness and fear are inevitable consequences of painful stimulation. Secondly, the fact that encounters with electric shock reduce the impact of later encounters with shock, if generalizable to painful stimulation in general, argues strongly against the inevitability of anxiety and fear as the consequence of painful stimulation in infancy. Because conditioned fears are also facts, however, we have a new quandry. What are the factors that determine whether the consequences of painful stimulation will be conditioned fears or will be adaptations to painful stimulation?

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AN EMPIRICAL ANALYSIS OF THE EFFICACY OF THE WISC IN THE DIAGNOSIS OF ORGANICITY IN CHILDREN OF NORMAL INTELLIGENCE*[1], [2]

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A. INTRODUCTION

The role of the Wechsler scales as a diagnostic aid is a subject on which wide disagreement is found. Relevant studies show conflicting and, for the most part, inconclusive results. Aita (1) reported that the comprehension subtest was one of the scales adversely affected by brain injury, whereas Allen (2) listed it as one of the least impaired. Many investigators (1, 2, 3, 14, 15, 19, 26) have claimed diagnostic significance for certain of the various subtests. Other investigators (5, 6, 9) have reported essentially negative results with subtest-pattern analysis. Low scores on the Block-Design, Coding, Arithmetic, and Digit-Span subtests have been cited most frequently as being symptomatic of neurological dysfunction, although all but three of the subtests (information, vocabulary, picture completion) have been cited as a typical trait by at least one writer. Verbal-performance *IQ* differences are frequently cited as having specific diagnostic meaning; e.g., Bakwin (4, p. 27) have recently stated:

> Children with cerebral damage, from whatever cause—anoxia at birth, trauma, infection—usually score low in performance. The WISC is an excellent aid in differentiating this group.

One is usually unsuccessful, however, in locating research corroborating such statements.

Some writers have generalized results obtained with the Wechsler-Bellevue Intelligence Scale or with the Wechsler Adult Intelligence Scale to the Wechsler Intelligence Scale for Children [WISC (5)], without presenting any empirical evidence justifying such inferences. As Yates (28) has stated:

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* Received in the Editorial Office on November 1, 1962. Copyright, 1964, by The Journal Press.

[1] A grant by the California State Bureau of Crippled Children Services to the Los Angeles County Schools provided the major portion of the diagnostic expense.

[2] The writer is indebted to Dr. W. B. Michael for his suggestions pertaining to the statistical treatment of the data.

> It is doubtful whether any aspect of psychological testing has been more inadequately treated than the diagnostic assessment of brain damage.

To the present, only two studies (5, 29) have been reported in which the WISC was used with children with organic brain disorders. Young's study (30) was made with Negro children with congenital syphilis, all of whom lived in the rural areas of Georgia. Beck's study (5) dealt with mentally defective children with brain injury. As yet, no study appears to have been reported on the diagnostic usefulness of the WISC with brain-injured children of normal *IQ*. As Strauss and Kephart (23) pointed out:

> The diagnostic value of items or pattern analysis of performance on the *Wechsler-Intelligence Scale for Children* is essentially an unexplored area.

B. Problem

The purposes of this study were to answer the following questions: (*a*) Is there a characteristic subtest pattern with neurologically handicapped children capable of yielding meaningful diagnostic information? (*b*) Is there a significant difference between Verbal and Performance *IQ*s for this group? (*c*) Do brain-injured children of normal intelligence manifest greater intratest or intertest variability of "scatter" than "normals"? (*d*) Can findings obtained with the adult Wechsler scales, *ipso facto,* be generalized to the scale for children?

C. Procedure

1. *Subjects*

The subjects (*S*s) involved in this study resulted from an extensive screening of approximately 25,000 pupils in three elementary-school districts in Los Angeles County.

a. Diagnosis. In each class, the teacher rated the one, two, or three pupils who, to the greatest extent, manifested the traits described in Burk's Rating Scale for Cerebral Dysrhythmia. The *S*s who seemed to show a pattern of symptoms typical of neurological dysfunction were given the following battery of psychological tests: (*a*) the Wechsler Intelligence Scale for Children, (*b*) the Bender-Gestalt Test (and recall), (*c*) the Goodenough Intelligence [Draw-a-Man] Test, (*d*) the Draw-a-Diamond Test, and usually the Wide-Range Achievement Tests. Evaluations of each *S*'s ability and achievement level were also obtained from the classroom teacher and from previous educational and psychological tests.

Because the study was delimited to persons of "normal" *IQ,* all *Ss* who scored below a full-scale *IQ* of 80 on the WISC were dropped from the identification process. *S*s remaining were examined by the school physician and additional screening was made at this point. A neurologist and a pediatrician then obtained developmental histories from the parents and each made an independent neurological examination. The school psychologist and a consultant in research and guidance interpreted the psychological findings. EEG's were then obtained on those who were not screened out and, on the basis of the overall findings, a medical diagnosis was made. Thirty-three brain-injured *S*s were identified; their mean age was 8.47 years, with a standard deviation of 1.43 years; they ranged in age from 6 years and 0 months to 11 years and 11 months. It should be pointed out that the only child studied was the child with undifferentiated neurological dysfunction. Children with epilepsy, cerebral palsy, and other specific clinical types of organicity were not included. Most of the *S*s had histories of difficult births, encephalitis, meningitis, extended periods of high fever, or severe head injuries.

The investigator set $a = .01$ because the multiple comparisons involved would bring the probability of making a Type I error to .5 or higher at the conventional .05 level of confidence.

D. RESULTS

1. *Subtest Differences*

Because the clinical use of subtest patterns is necessarily intraindividual, the same method must be used in assessing the significance and validity of subtest patterning. Through the use of the standard scale scores, *S*'s performance on certain subtests is compared with his performance on other subtests or on patterns of subtests, relative to the standardization population. It is the relative differentials that are purported to be of diagnostic value. The standardization population is then, in essence, the control group because the normative scale scores provide the basis of comparison.

An analysis of variance was made using the method appropriate for correlated measures, as described in Edwards (8). The results, given in Table 1, indicate that there are differences between subtests which are highly significant.

An adaptation of Duncan's multiple-range test for correlated means [described by Edwards (8)] was used to isolate specific significant differences between subtest means. The results are given in Table 2. It can be seen that 15 of the 91 differences prove to be significant; 11 of these involve combinations of the two subtests having the lowest means (arithmetic and coding).

It should be noted that the significant differences are group differences;

TABLE 1
ANALYSIS OF VARIANCE OF WISC SUBTESTS WITH BRAIN-INJURED CHILDREN OF NORMAL INTELLIGENCE

Source of variation	Sum of squares	*df*	Mean square	*F*	.01*
Between rows (subjects)	1059.0	32	39.09	10.15	1.73
Between columns (tests)	462.4	13	35.57	10.91	2.08
Residual (error)	1357.6	416	3.26		
Total	2879.0	461			

* Value of *F* required for significance at the .01 level.

much greater differential performance is required in the individual case in order to be interpreted as a nonchance finding (13). This fact is frequently overlooked by those advocating the clinical use of subtests. Wechsler (26), for example, presents sample "characteristic profiles" of various clinical types (e.g., anxiety states, organic brain disease, etc.), yet it has been shown (13) that the differences between subtests presented (by Wechsler) are not large enough to cause one to reject the null hypothesis of chance variation, even at the .05 level. In the present sample, in which there is intrinsic criterion contamination, only 13 per cent of the "significant" group findings are statistically significant ($\alpha = .01$) for the individual *S*s. This is a very discouraging finding as far as the diagnostic value of subtests is concerned. Twelve *S*s had at least one subtest difference significant in the direction *opposite* to that of the group difference. If the subtests are used diagnostically, should not negative diagnostic phenomena be considered as well as "positive" phenomena?

2. *Scatter*

To discover whether there was significantly more intratest variation in the sample than in the population, the variance for each subtest was computed for the sample. Because all *S*s with *IQ*s below 80 had been eliminated, each variance estimate was corrected for restriction of range, using the method described in Guilford (10). When this corrected variance was compared with the population variance value of 9, the largest of eleven *F*-values was 1.39, which value falls well below the necessary .01 (or even .05) critical value.

It is apparent that as a group the neurologically handicapped children did not have more intratest variability than did the normal children in the standardization sample. Consequently, with brain-injured children, one is no more likely to find greater scatter on any particular subtest than with a "normal" population.

Intertest scatter was analyzed by correlating each subtest with the full-scale score. The lower the correlation between a subtest score and the full-scale

TABLE 2

Duncan's Multiple Range Test Applied to Subtest Differences on the WISC*

Subtest	Picture completion	Comprehension	Object assembly	Block design	Vocabulary	Picture arrangement	Performance**	Full scale**	Verbal**	Similarities	Information	Digit span	Coding	Arithmetic
Mean	10.30	10.24	10.06	10.03	9.79	9.48	9.39	8.90	8.64	8.61	8.58	8.43	7.61	7.48
							———	———	———	———	———	———	———	———
						———	———	———	———	———	———	———	———	
			———	———	———	———	———	———	———	———	———	———		
		———	———	———	———	———	———	———	———	———	———			
	———	———	———	———	———	———	———	———	———					

* Any two subtest means not underscored by the same line are significantly different (.01).

** Converted to the common standard score scale ($M = 10$, $s = 3$) for purposes of comparison.

score, the more extreme the scatter is to be expected. As compared with those for normal children, the correlations just mentioned were hypothesized to be significantly lower; hence greater subtest scatter with neurologically handicapped children was anticipated. The correlation coefficients were corrected for the slight restriction of range and tested for significance against the corresponding coefficients given in the manual (25). The results are given in Table 3.

The digit-span and picture-arrangement subtests show significantly lower correlations with the full scale than those reported for the population. Consequently, scores on these scales show a greater lack of correspondence with the general full-scale rating than do the other scales and support the scatter hypothesis for the *group*.

Although this finding is of general importance and is consistent with neurological theory, it is difficult to see how it can be of much value for individual diagnosis. It is important to note that, for each of the nine other scales, the scatter hypothesis was rejected.

3. *Verbal-Performance Relationship*

The verbal-performance relationship frequently is quoted in the literature as having diagnostic significance. Several investigators (2, 20, 26) have stated that a verbal-higher-than-performance score tends to be a characteristic of brain-damaged adults. In the present study, 22 of the 33 children show the *reverse* relationship; in fact, the mean performance *IQ* is (at the .01 level) significantly higher than the mean verbal *IQ*. Thus, statements pertaining to the adults' scales cannot *ipso facto* be generalized to the scale for children.

E. Discussion

If Hebb (12) is correct, consistent differential performance for neurologically handicapped children would not have been predicted. He states:

> . . . cerebral organization shows an increase in differentiation and integration with age, the less differentiated structure in the child leads to a more diffuse effect of injury. . . .

Some diagnosticians (3, 26) appear to oversimplify the conditions of brain injury—by considering those with positive diagnoses as a homogeneous group, at least as far as differential cognitive functioning is concerned. Even though the general localization of functions in the brain is well understood, some authorities (26, p. 223) seem still to expect a "typical" subtest pattern regardless of the type or location of the lesion. Many investigators (7, 11, 22, 24, 27) have demonstrated that the decisive factor determining the effects of brain

TABLE 3

CORRELATIONS BETWEEN SUBTEST AND FULL-SCALE SCORES BEFORE AND AFTER CORRECTION FOR RESTRICTION OF RANGE

Statistic	Information	Comparison	Arithmetic	Similarities	Vocabulary	Digit span	Picture completion	Picture arrangement	Block design	Object assembly	Coding
r_{12}	.76	.43	.34	.58	.72	.03	.44	.16	.39	.32	.17
R_{12}	.86	.58	.45	.72	.84	.05	.59	.23	.51	.44	.25
t	2.53	—.55	—1.70	.86	1.88	—4.13*	.29	—3.44*	1.03	—1.51	—1.42

* Significant at the .01 level. A negative t ratio shows that the correlation was less in the sample than in the general population.

injury on intelligence test performance is the localization of the lesion. Weinstein and Teuber (27, p. 1037) have stated:

> Trauma in different brain loci may produce none or different degrees of cognitive (and other) mental defects, and that trauma in a given brain locus may produce different symptoms in different individuals.

Meyer (18) and Riese (21) have emphasized that different kinds of lesions in the same location can also produce different psychological concomitants.

Another important factor that makes impossible a definitive, individual diagnostic use of the Wechsler subtests is the lack of reliability possessed by the difference scores. The median reliability of the subtest difference has been shown, by Hopkins and Michael (13), to be .54. McNemar's statement regarding the WAIS (17, p. 127) is also appropriate for the WISC:

> . . . the author of the WAIS has attempted an impossible task; the construction of a scale to measure general (global) intelligence which at the same time will provide differences among subtests which are of diagnostic value.

Before we can arrive at a definitive, predictable relationship relating to neurological dysfunction (so far as the psychometric effects are concerned), greater consideration must be given to degree, stage, locus, and type of impairment, as well as to the types of scales that will be sensitive and reliable enough to assess these effects.

F. SUMMARY

An analysis of WISC scatter patterns was made of a carefully identified group of 33 children of normal *IQ*, diagnosed medically as having neurological impairment. Although several significant differences between subtests were discovered, most of these resulted from the two subtests with the lowest means (arithmetic and coding). Due largely to the low reliabilities possessed by the difference scores, the findings indicate limited diagnostic significance for the individual case because of the large-scale score-difference required for significance with a sample of one.

The hypotheses of greater intertest variability were rejected on all subtests except the Digit-Span and Picture-Arrangement subtests. Contrary to statements—regarding the adult scales—by Allen (3), Patterson (20), and Wechsler (26) there no tendency was found for performance *IQ*s to be higher than verbal *IQ*s. It is clear that, without corroborating research, relationships found for adults cannot be generalized to tests on children. The discussion emphasizes that there are many different kinds of brain damage;

hence to expect a homogeneous effect on a psychological test seems to oversimplify the problem and is inconsistent with the indications of neurological research.

The present investigation, it is hoped, will have a salutary effect on the widespread misunderstanding regarding the nature and complexity of the psychometric concomitants of neurological dysfunction and on the efficacy of the WISC in measuring differential cognitive abilities.

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PERCEPTUAL ANALYSIS AND SENSORY INTEGRATION IN BRAIN-DAMAGED PERSONS*[1]

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A. INTRODUCTION

In two independently conducted investigations of perception in brain-damaged (hemiplegic) adults (1, 2), the findings indicated that brain-injured patients are (*a*) inferior to normal persons in their capacity to use somesthetic information effectively in judging the visual vertical and (*b*) defective in their ability to analyze complex visual patterns. The question naturally arises as to whether these impairments represent diverse manifestations of a common disturbed function, or, alternatively, reflect the disordering of independent mechanisms of perceptual organization. The opportunity to explore this question existed in our data because both the study of impaired usage of non-visual information in judging visual verticality and the investigations of perceptual-analytic impairment were conducted on the same sample of individuals. The present report, therefore, is concerned with an examination of the relationship between perceptual-analytic and visual-somesthetic functioning in normal and brain-damaged persons. Such an examination should provide evidence concerning the relationship between the ability to engage in perceptual analysis and the ability to use effectively intersensory and intrasensory cues.

B. METHODS

For the examination of the capacity to use intersensory cues, the method used was to require the subject to adjust a luminous rod to the true upright position in a fully darkened room. In this situation, judgment of verticality was the product of an interrelation between the visual stimulus and the information derived from somesthetic and proprioceptive systems. The subject was required to make 20 judgments.

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The capacity to use intrasensory cues was examined by requiring the subject to adjust the luminous rod to the true vertical position when it was presented within a tilted frame in a darkened room. In the rod-and-frame situation, a perceptual choice problem is created wherein the individual's judgments may be based either upon a visual-somesthetic interrelation (intersensory) or upon a visual-visual interrelation (intrasensory). Twenty judgments were made by each subject in this situation. A full description of the procedures followed in the rod and in the rod-and-frame tasks is reported in a previous paper (2).

The ability to analyze complex visual patterns was examined by using the patient's responses to the inquiry phase of the Rorschach test. The patient's responses during the inquiry period of testing provided evidence that indicated his ability to delineate the parts and qualities of the blot that contributed to his perceptions. In this phase of the examination, the patient was required to specify (in the stimulus) the perceptual subwholes that provided the basis for his responses. This requirement constitutes a request for an analysis of the percept into subwholes by the patient and, in fact, represents a task similar to the identification of hidden figures. A complete description of the procedure used is available in a previous report (1).

C. SUBJECTS

From an available population of 400 left-hemiplegic patients, 18 subjects were selected. They met the following criteria: (*a*) They were chronic cases in whom hemiplegia had been present for at least seven months. (*b*) They had no gross expressive or receptive language disturbance. (*c*) They had no hemianopia that appeared to influence visual perception significantly.[2] (*d*) They had no other uncorrected visual or significant auditory defect. The 16 non-brain-damaged subjects were selected to match the hemiplegic group for age and sex. Table 1 contains the sex and age characteristics of the patients.

TABLE 1
SEX, AGE, AND NUMBER OF SUBJECTS

	Number of subjects			Mean age of subjects			Age range of subjects		
Group	Total	Male	Female	Total	Male	Female	Total	Male	Female
Brain-damaged (left hemiplegic)	18	11	7	65.3	65.5	65.1	46-81	46-81	57-72
Control	16	10	6	64.5	65.0	63.7	50-79	50-79	54-77

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[2] Five patients had field defects which were demonstrable on perimetric examination. However, the performances of these patients were indistinguishable from those of the other hemiplegic patients.

Neurological and visual perimetric examinations were performed for the hemiplegic group and the results of these examinations are fully reported in a previous paper (2).

D. RESULTS

The results obtained from the performances of the brain-damaged and of the control patients in judging the upright and, on the Rorschach, the perceptual-analytic tasks are presented in Tables 2 and 3.

TABLE 2

ERRORS IN THE JUDGMENT OF VERTICALITY MADE BY THE BRAIN-DAMAGED AND CONTROL GROUPS

		Average error#			
		a. Simple-rod situation		b. Rod-and-frame situation	
Group	*N*	Mean	*SD*	Mean	*SD*
Brain-damaged	18	7.8	4.5	17.0	5.6
Control	16	3.6	1.9	17.1	6.4
t		3.8*		n.s.	
F			5.4**		n.s.

# Average error indicates magnitude of error in the judgment of verticality independent of direction.

* $p < .005$, Cochran-Coxe correction applied.

** $p < .01$.

An examination of Table 2 (Part a) indicates that in the simple rod situation the brain-damaged patients exhibit a significantly larger magnitude of error in their judgments of verticality than do the control patients. In addition, the brain-damaged patients manifest significantly greater variability in their judgments ($F = 5.40$, $p < .01$). The results in Table 2 (Part b) indicate that, in the rod-and-frame task, the brain-damaged and the non-brain-damaged patients produce a similar magnitude of error in judging verticality.

The results of the perceptual-analytic test performance are presented in Table 3. They reveal that a significantly greater number of brain-damaged

TABLE 3

NUMBER OF BRAIN-DAMAGED AND CONTROL SUBJECTS WHO PRESENTED A HIGH AND LOW PERCENTAGE OF WELL-ANALYZED PERCEPTUAL RESPONSES

		Per cent of Well-Analyzed Responses*	
Group	*N*	71 per cent and above	56 per cent and below
Brain-damaged	18	6	12
Control	16	12	4

* The subject's scores for well-analyzed responses ranged from 19 per cent to 100 per cent with a large gap in scores existing between 56 per cent and 71 per cent. Chi square = 4.35, $p < .05$.

patients exhibit poorer ability to analyze their own spontaneously reported Rorschach percepts into perceptual subwholes than do control patients.

The perceptual-analytic data were related to the intra- and intersensory findings in several ways. In Table 4, all subjects were combined and divided into good and poor perceptual analyzers. It was found (see Part a of Table 4) that the good analyzers are the significantly better utilizers of intersensory information and are significantly less variable in their responses. Part b of Table 4 indicates that, for the combined group, perceptual-analytic ability bears no significant relation to the effective use of intrasensory (visual) information, in making judgments of the visual upright.

TABLE 4
RELATION OF PERCEPTUAL ANALYSIS TO INTRA- AND INTERSENSORY INTEGRATION FOR ALL SUBJECTS COMBINED

Quality of perceptual analysis in Rorschach task (all subjects combined)	N	Upright average error a. Intersensory Mean	 SD	 b. Intrasensory Mean	 SD
Good analyzers:					
71 per cent and above	18	3.6	2.0	17.3	6.0
Poor analyzers:					
56 per cent and below	16	8.1	4.8	17.7	5.1
t		3.6*		n.s.	
F			5.8**		n.s.

* $p < .005$, Cochran-Coxe correction applied.
** $p < .01$.

In Table 5, the subjects were studied by dividing both the control group and the brain-damaged group into good and poor perceptual analyzers and relating this categorization to their performances on the intersensory task. As may be seen in Part a of Table 5, good perceptual analyzers among the controls are significantly more accurate judges of the upright ($t = 2.88$,

TABLE 5
RELATION OF PERCEPTUAL ANALYSIS TO INTERSENSORY INTEGRATION FOR CONTROL AND BRAIN-DAMAGED SUBJECTS

Quality of perceptual analysis in Rorschach task	Upright average error a. Control subjects N	 Mean	 SD	 b. Brain-damaged subjects N	 Mean	 SD
Good analyzers:						
83 per cent and above	9	2.3	0.7	9	6.3	3.6
Poor analyzers:						
79 per cent and below	7	4.7	2.1	9	9.2	5.2
t		2.9**			1.4*	
F			7.2***	9		2.1*

* Not significant.
** $p < .05$, Cochran-Coxe correction applied.
*** $p < .02$.

$p < .05$) and are significantly less variable in their judgments ($F = 7.22$, $p < .02$) than are poor perceptual analyzers. When the data of the brain-damaged subjects are analyzed in the same way (see Part b of Table 5), no significant differences in the judgments of the upright exist between the good and the poor perceptual analyzers.

Table 6 extends the analysis developed in Table 5 to the consideration of judgments made on the intrasensory task. As may be seen in Part a of Table 6, good analyzers among the control subjects do not differ significantly from poor analyzers, in the accuracy of their judgments of the true upright. However, in their judgments under intrasensory conditions, poor analyzers are significantly less variable in their judgments than are good perceptual analyzers ($F = 26.5$, $p < .005$). Brain-damaged patients (see Part b of Table 6.) show no significant differences between good and poor perceptual analyzers, in ability to judge the upright under intrasensory conditions.

TABLE 6

RELATION OF PERCEPTUAL ANALYSIS TO INTRASENSORY INTEGRATION FOR CONTROL AND BRAIN-DAMAGED SUBJECTS

	Upright average error			
	a. Control subjects		b. Brain-damaged subjects	
Type of analyzer	Mean	*SD*	Mean	*SD*
Good	16.9	7.6	15.3	6.2
Poor	18.7	1.7	19.2	4.1
t	0.6*		1.6*	
F		26.5**		2.3*

* Not significant.
** $p < .005$.

For all subjects, as well as for the brain-damaged and control groups considered separately, the correlations between perceptual-analytic performance and ability to judge the visual vertical are positive under both inter- and intrasensory conditions (see Table 7). However, none of the correlational values for the intrasensory conditions achieve an acceptable level of statistical significance.

TABLE 7

CORRELATION OF PERCEPTUAL ANALYSIS TO INTER- AND INTRASENSORY UTILIZATION

		Correlation values* of perceptual-analytic ability and judgment of visual verticality	
Group	*N*	Intersensory condition	Intrasensory condition
Combined groups	34	.50**	.12
Brain-damaged	18	.36†	.17
Control	16	.72**	.11

* Pearson product-moment correlation.
** $p < .01$.
† Not significant.

Under intersensory conditions, for all subjects and for the controls, the correlations between judgment of verticality and perceptual-analytic ability are significant at the .01 level of confidence. The performances of the brain-damaged subjects, however, did not result in a correlation value for this condition that was statistically significant. Therefore, it appears that the significant correlation coefficient obtained for all subjects is largely the result of the contribution made by the controls.

E. DISCUSSION

When the control and brain-damaged groups are compared with reference to their intersensory and to their intrasensory functioning it is found that, although the two groups do not differ significantly from one another in their intrasensory abilities, a significant deficiency in the utilization of intersensory information exists in the brain-damaged group. If these findings are considered from the point of view of the development of perceptual functioning, they may be assimilated to Jackson's view (3) that later and more complex capacities are more readily disordered by cerebral damage than are simpler and earlier established capacities. Fragmentary evidence, in the study of perceptual development in childhood (4, 5), indicates that multisensory information may interfere with the accuracy of judgment in younger children, but result in improved accuracy in the older child and in the adult. It appears, therefore, that in patients with cerebral damage the less complex and earlier-developed intrasensory integration tends to be spared, whereas intersensory integrations are seriously affected.

The relationships between the abilities to dissect complex percepts into subwholes and to correctly judge the visual upright is markedly different for patients with brain damage and for the controls. Within the normal group, a positive relationship is found between perceptual-analytic ability and the successful utilization of intersensory information. However, within the brain-damaged group this relationship does not hold. It appears that cerebral injury causes the selective loss of one of these capacities, but not the loss of the other. Thus, some brain-damaged patients retain a good level of perceptual-analytic ability, but cannot use intersensory information effectively. These findings suggest that the ability to analyze complex patterns of visual stimulation into subwholes may involve a different integrative system from the one that is required for the performance of tasks based upon intersensory integration. These systems, correlated in the normal person, are dissociated in the brain-damaged patient.

F. SUMMARY

The interrelationships between two conditions for judging visual verticality (intrasensory and intersensory) and the capacity to analyze complex visual percepts into subwholes were studied in 16 normal and 18 brain-damaged (hemiplegic) patients. It was found that interrelations between perceptual-analytic ability and the perception of visual verticality are significant in controls, when the judgment of the upright is based upon intersensory information. Such a relationship does not hold for the cerebrally damaged group. The findings were discussed in terms of the hierarchical organization of sensory systems in perception and in terms of dissociation of the functional mechanisms of perception in patients with cerebral damage.

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ATTEMPTED SUICIDE AND FAMILY DISORGANIZATION*

Division of Mental Health, Philadelphia Department of Public Health

JACOB TUCKMAN AND WILLIAM F. YOUNGMAN

A. INTRODUCTION

The interrelation of attempted suicide, family disorganization, and delinquency has been demonstrated in a sample of 100 children and adolescents under 18 years of age (6). Family disorganization was defined operationally as contact, by the adolescent making the suicide attempt or by a member of his family, with one or more community agencies providing health and welfare services. Such a definition seems to have considerable validity because contacts with community agencies indicate that the family has a problem of such magnitude that it cannot cope with it through its own resources and requires help from specialized community facilities; moreover, it is a more objective measure of family disorganization than judgments based on retrospective accounts obtained through interview. The amount of agency contact, by children and adolescents attempting suicide or by members of their families, ranged from 17 per cent for agencies providing psychiatric services to 51 per cent for agencies concerned with delinquency. Without regard to the type of agency, 75 per cent of the sample had been known to one or more agencies.

The purpose of this study is to test whether the interrelationship of attempted suicide, family disorganization, and delinquency previously found for children and adolescents applies to adults (18 years of age and older).

B. SAMPLE AND PROCEDURE

From a study of 1,112 consecutive attempted suicides coming to the attention of the Philadelphia Police Department during the two-year period April, 1959, to April, 1961 (7), a 20 per cent random sample of 223 individuals was drawn for the present investigation. As in the study of children and adolescents, information concerning agency contacts was obtained through the Social Service Exchange, the clearing house in the community for registration of persons known to health and welfare agencies. Information was sought not only for the person making the attempt, but also for his spouse, parents, children, and siblings; but no information was sought for grandparents, aunts,

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uncles, relatives of the spouse, or relatives of the siblings (except for parents). Only contacts before the date of the attempt were used.

In 186 of the 223 cases, the Social Service Exchange was able to determine whether the person making the attempt or members of his family had been known to any agencies in the community. In 21 cases the identifying information (i.e., age, race, address, etc.) was not sufficient for the Social Service Exchange to determine whether the individual had had any agency contact. In 16 cases it was possible that the individual had had contacts, but no definite determination could be made with the available information. The study therefore was limited to the 186 cases who could be identified. Of these 186 cases, 69 per cent were female and 31 per cent were male; 75 per cent were white and 25 per cent were nonwhite. The age distribution showed 24 per cent between the ages of 18 and 24, 33 per cent between 25 and 34, and 43 per cent were 35 years of age or over.

In the earlier study, each agency to which the adolescent or his family had been known was asked for more detailed information about the nature of its contact with the family, with particular emphasis on relevant background factors. However, in general, the data obtained in that way yielded little information not already available from a knowledge of the functions of the agencies. Therefore, this procedure was not followed in the present study.

The health and welfare agencies were classified into the following categories, according to the system used in the earlier study:

1. Health: in or outpatient care at hospital or clinic for a physical condition.
2. Psychiatric: in or outpatient care.
3. Economic: public assistance.
4. Protective: care and placement of neglected children.
5. Delinquency: police, court, correctional institution, probation.
6. Domestic relations: Municipal Court for Domestic Relations.
7. Counseling: family, school, marriage clinic.
8. Other: Red Cross, legal aid, day care center, etc.

C. Findings

Fifty-one per cent of the families had been known to one or more health and welfare agencies; this is an underestimation because only contacts by the person making the attempt, spouse, parents, children, and siblings were considered. Although data are not available regarding the extent to which the general population requires the services of community agencies, it seems reasonable to say that the families in this study have had greater contact than most families.

The number of agency contacts ranged from 0 to 22. Forty-nine per cent of the families had had no contact, 35 per cent had had from one to five contacts, 11 per cent had had from six to 10, two per cent had had from 11 to 15, three per cent had had from 16 to 20, and one per cent had had more than 20. The total number of agency contacts was 476, distributed by type as follows: domestic relations, 23 per cent; protective, 21 per cent; health, 17 per cent; delinquency, 15 per cent; economic, 13 per cent; counseling, 6 per cent; psychiatric, 3 per cent; and other agencies, 3 per cent. Five per cent of the families accounted for 32 per cent of all contacts; 10 per cent of the families, for 50 per cent of all contacts.

A comparison of cases known to health and welfare agencies with those not known to any agency showed no significant difference between the two groups with respect to race, sex, age, marital status, method, type of poison (when poison was the method), time of day of the attempt, police description of the person's condition when he was found, circumstances precipitating the attempt (reported by the person making the attempt or by another respondent), time interval between attempt and discovery, physical health, mental health, previous threats or attempts, and presence of a suicide note.

The distribution of contacts by type of agency and by family composition is shown in Table 1. Because a small number of families had a disproportionate number of contacts, this effect was controlled in the following manner. Duplication was eliminated for number of contacts, under each type of agency. For example, contacts with five different health agencies by an individual were considered as only one contact with a health agency. In Table 1, such contacts are shown for each type of agency for each family member, but the overrepresentation of a small number of families was minimized further by eliminating duplication for (*a*) type of agency—e.g., contacts with eight different types of agencies were shown as only one contact with any agency; and (*b*) family composition—e.g., contact with health agencies by the person making the attempt, and by any or all of the other family members (i.e., spouse, parents, children, and siblings) were shown as only one family contact.

The data in Table 1 clearly indicate that family breakdown or family disorganization characterizes the life experience of persons attempting suicide. For problems in domestic relations, 34 per cent of the families had contact with the Municipal Court. The nature of the contacts varied. Most frequently, they involved court action against the father for failure to support

TABLE 1
PER CENT OF UNDUPLICATED HEALTH AND WELFARE AGENCY CONTACTS (BY TYPE OF AGENCY AND FAMILY COMPOSITION) FOR 186 ATTEMPTED SUICIDES

Family composition	Type of agency Domestic relations	Health	Protective	Delinquency	Economic	Counseling	Psychiatric	Other	Contact with any agency*
Person attempting suicide	20	9	10	12	8	5	2	2	41
Spouse	1	1	6	2	1	1	2	1	11
Parents	15	9	3	4	10	1	2	0	24
Children	3	4	4	4	2	2	0	2	13
Siblings	12	9	8	7	6	4	2	3	21
Families**	34	23	21	20	19	12	6	6	51

* Contacts with more than one agency were counted as only one contact.

** Includes person making the attempt, spouse, parents, children, or siblings, but counted only once as a family.

his family or his illegitimate children; less frequently, marital conflict was so great as to force one of the partners, usually the wife, to take action against the other. Twenty-one per cent of the families had contacts with agencies providing protective services for children, usually the Society to Protect Children from Cruelty, suggesting a home situation so detrimental to the welfare of children that intervention was necessary. In most of these cases, the children were removed from the home and placed in institutions or in foster homes. Nineteen per cent of the families had had contacts with agencies providing economic assistance; and 23 per cent, with health agencies for in- or outpatient physical care. Of course, there is overlap between the two because families unable to maintain themselves financially are not able to meet in part or in full the cost of medical care.

Twenty per cent of the families had a history of delinquency. Most of the contacts involved delinquent behavior in childhood and in adolescence and, in a few cases, criminal activities in adulthood. Twelve per cent of the families had been known to counseling agencies and six per cent to psychiatric facilities, usually outpatient clinics. Most of the counseling and psychiatric contacts, initiated by school or police rather than by the family, involved children presenting behavior difficulties in school, often a precursor of delinquency.

The data in Table 1 clearly indicate the pervasiveness of family breakdown, as shown by the involvement of its members in independent agency contacts. The differences in involvement among family members must be accepted with considerable caution. In some cases, the differences are a function of age and life experience. For example, it would hardly be expected that any significant number of children would have had domestic relations contacts because the median age of their parents (the persons attempting suicide) was only 32.5 years. In time, as more of the children reach adulthood, more may be involved in such contacts. In most cases, the differences among family members are a function of the way agency contacts are classified. For example, contacts for domestic relations were arbitrarily shown only for the person making the attempt even though the spouse was also involved. Agency contacts for economic assistance were arbitrarily shown only for the person making the attempt even though spouse and children were also involved. By contrast, contacts for protective services were arbitrarily shown only for the child. Such contacts shown for other family members refer to the need for protective services when they were children. Although the method of classifying agency contacts minimizes the involvement of family members, the pervasiveness of family breakdown is evident. Forty-one per cent of the persons making the attempt were involved in a contact with some type of agency; 24 per cent of parents, 21 per cent of siblings, 13 per cent of children, and 11 per cent of spouses were also involved in independent contacts. Further analysis shows that the contacts tended to be by individuals within the same family unit rather than by unrelated persons. In 63 per cent of the families with any agency contact, two or more members were involved in independent contacts; in 53 per cent, two or three generations were involved.

D. Discussion and Conclusions

There are differences between the present study and that of attempted suicide by children and adolescents. Family breakdown, as measured by contacts with health or welfare agencies, was more prevalent among children and adolescents (75 per cent of the families) than among adults (51 per cent). Furthermore, the distribution of the areas of breakdown showed that delinquency was relatively more important among children and adolescents, while domestic relations problems were relatively more important among adults. One explanation for the differences may be that the younger the person making the attempt, the greater the amount of family disorganization, but this inference does not appear to be valid, as no differences were found between age and family disorganization in the adults sample. A more reasonable explanation for the differences may be (*a*) the tendency in recent years to focus more sharply upon multiproblem families, in which delinquency is an important aspect, and (*b*) the fact that 17 per cent of the adult sample lacked sufficient identifying information to determine whether they had been known to a health and welfare agency, whereas in the sample of children and adolescents all cases could be identified.

Whether or not the differences are real, it is clear (from the two studies) that family disorganization is characteristic of persons attempting suicide. This finding is consistent with those of other studies using different criteria of family breakdown: e.g., loss of parent through death of one or both parents, or absence of one or both parents due to separation, divorce, desertion, or illegitimacy (2, 3, 4); or broken home, based on factors such as parental rejection, emotional deprivation, parental quarreling, and alcoholism (1, 5). Although delinquency may be a more important aspect of suicidal behavior in children and adolescents than in adults, the pervasiveness of family disorganization (as seen in the involvement of different members of the family)—frequently over a period of two or three generations—emphasizes the complexity of the problem and the difficulty in separating cause and effect. This suggests the importance of other factors (e.g., marital discord, parental neglect, and emotional deprivation in childhood, physical illness, mental illness, economic dependency, and difficulty in interpersonal relations, as well as delinquency) in the association of family disorganization and attempted suicide. The particular area of breakdown emerging in any study of attempted suicide may be a function in part of the age and life experience of the members of the sample and in part of the kinds of social problems receiving most community attention.

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THE DEVELOPMENTAL POINT OF VIEW WITH SPECIAL REFERENCE TO THE PRINCIPLE OF RECIPROCAL NEUROMOTOR INTERWEAVING*

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A. INTRODUCTION

Behavior, like physical structure, has shape and pattern, and also like physical structure it grows through a series of patterned, predictable changes. The developmental point of view in child psychology has concerned itself with the study of those growth patterns that appear to characterize the growing human organism from the time of conception at least through adolescence. It holds, as Gesell has commented (2, p. 313), that "environmental factors support, inflect, and specify but they do not engender the basic forms and sequences of ontogenesis."

Investigators who work within the developmental frame of reference are concerned with three main aspects of behavior, and in this order: (*a*) common and characteristic age changes in behavior that appear to be shared by most growing human organisms; (*b*) individuality characteristics that uniquely and consistently characterize each individual human organism; and (*c*) environmental factors and the ways in which they can affect the organism, with reference to its age and individuality characteristics. The present paper discusses some of the basic principles that appear to lie behind the patterned changes in behavior that occur in infancy and childhood.

The chief principle that underlies the developmental point of view is the one named above: that behavior in virtually any field of human activity proceeds in a patterned lawful manner through stages that, though they may differ in their manner of expression and in their timing, are consistent in basic structure and sequence from one organism to another.

More specifically, we may name two principles: the *principle of developmental direction* and the *principle of reciprocal neuromotor interweaving.*

1. *Developmental Direction*

The principle of developmental direction recognizes that the action system of the infant does not increase symmetrically like an expanding balloon, but is

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subject to the far-reaching consequences of the biological factor of anterior-posterior differentiation. That is, the development of behavior abilities in the human organism proceeds in a cephalocaudad direction—from the head end to the foot end of the body. Thus the human infant in the first year of life gains reasonably adequate control of eyes, head, upper trunk, and arms long before he can effectively control his lower trunk and his legs.

Furthermore, just as neuromotor organization proceeds from head to foot in the direction of the longitudinal axis; so it tends to proceed from the central to peripheral segments. There is progressive advance of motor control from the larger fundamental muscles to the smaller muscles that execute the more refined movements. Thus during the earlier periods of development the arms and also the legs tend to react as wholes, the impulses arising mainly from the shoulder and from the pelvic girdles. With advancing maturity, mobility asserts itself at the elbow and wrist joints and at the knee and ankle joints. Forearm, foreleg, hand, and foot show specific segmental activity. Because the proximo-distal trends overlap with the cephalocaudal trends, independent activity of the distal segments becomes apparent in the upper extremities before it is evident in the lower extremities.

In the development of prehension there is not only a proximo-distal but also an ulnar-radial shift. The ulnar side of the hand is used effectively in grasping long before the radial side is used. This fact means that poking with the index finger and precise pincer prehension do not occur in the average infant until somewhere around 40 weeks of age, even though he may have been able to grasp objects crudely with the outer side of his hand long before this.

All of these laws of development as applied to human behavior have been recognized for a relatively long time and are described fully by Gesell and others in various publications (2, 3, 5, 6, 9, 10). Less familiar is the *principle of reciprocal neuromotor interweaving* (1) with which the present paper is concerned.

2. *Reciprocal Neuromotor Interweaving*

The principle of reciprocal interweaving, when applied at a simple motor level, implies neurologically an intricate cross-stitching or involuted interlacing that organizes opposing muscle systems into reciprocal and increasingly mature relationships. Functionally, such a process results in a progressive spiral kind of reincorporation of sequential forms of behavior. Flexion and extension are the most fundamental components of muscular movement. The inhibition of one set of muscles while the opposing muscles are in excitation is a condition for effective movement. Reciprocal innervation is a mode of coordination, a physiological mechanism.

In the ontogenesis of the neuromotor system a complicated integration must likewise be achieved between antagonistic muscles. Appropriate structures for subserving inhibition must be progressively provided. There is a mode of growth that asserts itself in a developmental fluctuation of dominance in flexors *versus* extensors and also in unilateral and crossed-lateral *versus* bilateral muscle groups.

More simply stated, it seems possible to identify (in any growing behavior) paired but opposed types of response that occur alternately, now one and now the other in repeated alternation, until the behavior has reached its final or complete stage. In practical everyday life, one of these two opposed types of response is likely to be thought of as immature or less desirable; the other, as mature and more desirable. When patterns of human behavior were first being identified and described, it was believed by some that behavior in the human infant and child developed in a straightline manner, being first immature and then gradually more mature. Careful observation, however, indicated that development was far more complex. Instead of the immature type of response dropping out completely once and for all and, with increasing age, being replaced by the more mature, it appeared that type of response alternated repeatedly between less and more mature.

However, this was not simply a matter of an infant going back to exactly the same earlier type of immature behavior, but rather it was as though the path of development spiralled upward from left to right (but always upward) stressing now the less mature and now the more mature side of the spiral.

a. Prone progression. This principle of development is perhaps most clearly expressed in the first year of life, as the infant develops the ability to crawl, to creep, to stand, and to walk. We have identified 22 stages which the normal infant customarily goes through as he lies prone (6). We note that, first, arms and legs are flexed; at a later stage they are extended; at a still later stage they are again flexed; still later they are extended; and so on repeatedly until finally the infant stands and walks erect.

The most conspicuous alternations in creeping behavior are the alternations of predominant flexion and predominant extension of the arms and of the legs. (See Figure 1). However, we may note also, as the patterns of prone progression unfold, an alternation of abduction and adduction of both arm and leg movements, and also of bilateral and unilateral movements.

Because the adult as a rule places no special value judgment on either flexor or extensor posturings, it is relatively easy for him to observe the patterned

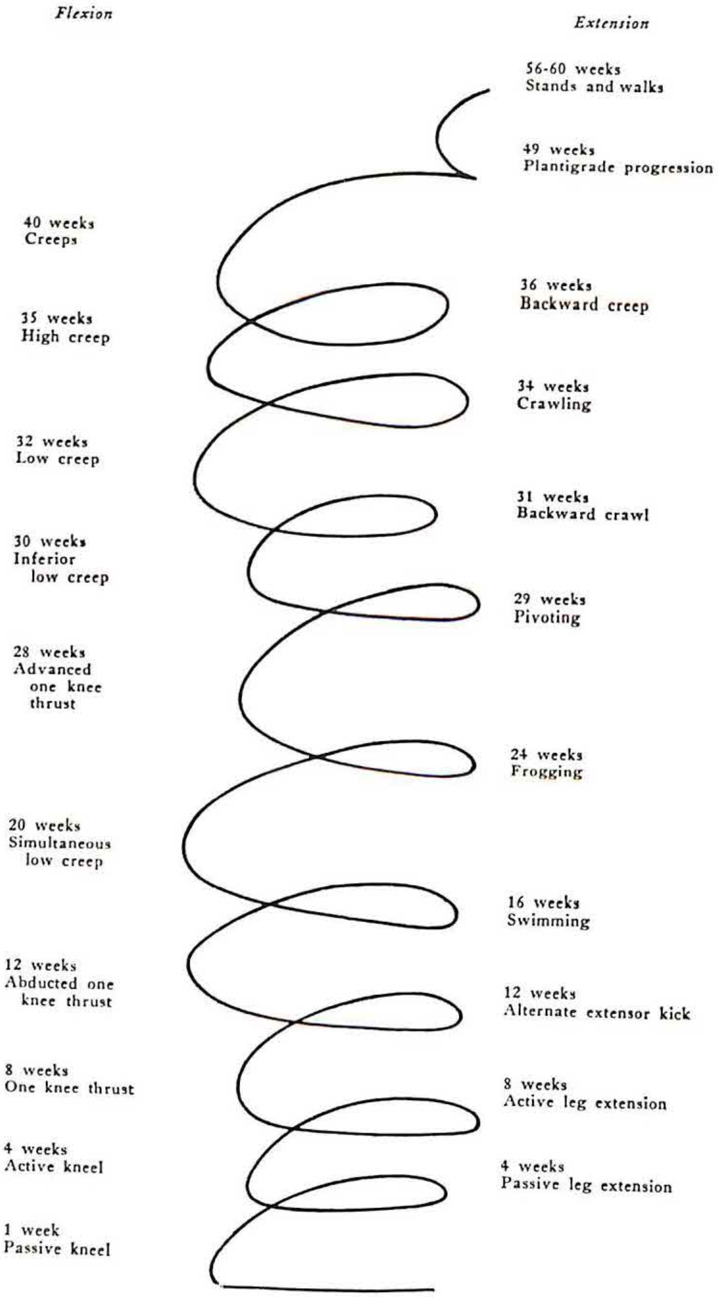
Flexion
Extension
56-60 weeks Stands and walks
49 weeks Plantigrade progression
40 weeks Creeps
36 weeks Backward creep
35 weeks High creep
34 weeks Crawling
32 weeks Low creep
31 weeks Backward crawl
30 weeks Inferior low creep
29 weeks Pivoting
28 weeks Advanced one knee thrust
24 weeks Frogging
20 weeks Simultaneous low creep
16 weeks Swimming
12 weeks Abducted one knee thrust
12 weeks Alternate extensor kick
8 weeks One knee thrust
8 weeks Active leg extension
4 weeks Active kneel
4 weeks Passive leg extension
1 week Passive kneel

FIGURE 1
RECIPROCAL INTERWEAVING

alternation of flexor and extensor stages objectively. For the most part, people do not believe that the child assumes these postures because of something that somebody has done or in response to other environmental stimuli. As the child grows older—and the kinds of behavior that characterize the succeeding age levels may be (and usually are) considered as good or bad by the culture—it becomes, for many, less easy to see the child's behavior as coming from within and occurring in response to internal-growth stimuli and more easy to consider that somebody has caused it. We cannot always prove that the behavior of concern is not externally caused, though we favor internal growth stimuli as the source.

We should like to demonstrate that the successive stages of prone behavior (at least) do not occur primarily in response to environmental stimuli—that is, the child does not assume various postures because, as he lies prone, he is trying to reach some desired stimulus object. Our evidence comes—by means of cinemanalysis (7)—from a careful comparison of typical postures in prone and supine positions. As the child lies on his back, with no stimulus object or goal or reasonable likelihood of progressing, he has been observed to assume posturings that correspond almost identically (with respect to timing of flexion, extension, unilaterality, bilaterality and the like) with the postures assumed by the prone infant. Table 1 compares characteristic prone and supine postures at succeeding age levels.

The alternating stages of flexion and extension that we see in prone progression do not as a rule concern the parent and, for the most part, knowledge of them is largely of theoretical importance.

b. Handedness. For handedness, the preceding statement is not true. There has been much discussion in the past (in both the scientific and in the popular literature) as to whether the adults should try to change a child's handedness, especially in instances when the child seems to prefer his left hand. Current opinion is that it is probably best not to interfere drastically in the matter, but rather to allow the child to use his preferred hand, especially when the preference is marked. Our own findings support this policy of non-intervention.

Careful observation of children who, as they grow older, showed marked and consistent preference for their right hands, has revealed the fact that establishment of handedness seems to be one of the many areas for which we can identify a principle of reciprocal interweaving at work.

Thus, as Figure 2 and the material below illustrate, even a child who (for all intents and purposes) is strongly and completely right handed does, in infancy at least and often for some months or years beyond, alternate in

TABLE 1

COMPARISON OF SPONTANEOUS SUPINE AND PRONE LEG POSTURES OF THE HUMAN INFANT*

	Supine	Prone
1 Week	Bilateral flexion in external rotation. Legs passive.	Bilateral flexion, nearly under trunk. Legs passive.
4 Weeks	Bilateral flexion, less passive. One leg flexes and extends.	Bilateral flexion, less passive. One leg flexes and extends.
8 Weeks	Like 4 weeks but less active. More bilateral extension in slight outward rotation.	Like 4 weeks but less active. More bilateral extension in slight outward rotation, feet raised slightly from supporting surface.
12 Weeks	Bilateral flexion with outward rotation and some extension at hips, feet invert. Legs flex, feet in step position, bilateral.	Legs extend in outward rotation with extension at hips. Bilateral. Move in a unilateral backward-upward kick or unilateral knee thrust.
16 Weeks	Bilateral extension, back arches. Bilateral flexion in abduction outward rotation at hips. Bilateral flexion, knees together, soles on platform; or unilateral posture, one foot on opposite knee.	Bilateral upward extension, back arches. Bilateral flexion in abduction, outward rotation. Unilateral forward knee thrust.
20 Weeks	Legs flex up toward trunk, knees together. Jerky flexion and extension of one or both legs.	Legs flex up toward (under) trunk, knees together. Jerky flexion and extension of one or both legs.
24 Weeks	Bilateral frogging, external rotation.	Bilateral frogging, external rotation.
28 Weeks	Foot to knee, or both legs flexed upward in external rotation, or both extend upward at right angles to trunk.	One knee thrust, or both legs extend.
32 Weeks	Like 28 weeks, but predominantly in bilateral extension in line with trunk. A transition age.	Pivoting. Inferior low creep position. Some bilateral extension, slightly frogged. Legs extend bilaterally. A transition age.
36 Weeks	Legs extend bilaterally, rather close together, feet straight. Legs flex up bilaterally. Legs flex feet in step position.	Legs extend bilaterally, or maintain bilateral flexion when child is in creep position.
40 Weeks	50 per cent of infants have legs predominantly in bilateral extension. Others have legs flexed, feet straight, in step position.	Both legs flex as child maintains creep position or creeps. Feet straight.

TABLE 1 (*continued*)

Supine	Prone
44 Weeks	
Legs extend in line with trunk, wider apart. Feet evert. Foot to knee. Legs flex, feet in step position; or one leg extends, one flexes.	Creeps one step with one leg flexed and one extended, one knee and one foot contacting supporting surface, or may creep with both legs flexed.
48 Weeks	
Legs extend, feet evert, legs wide apart. Legs frog loosely (i.e., maintain external rotation), feet evert.	All fours, both legs extended, feet everted, weight on hands and feet. Legs at right angles to trunk.
52 Weeks	
Legs extend, feet straight, legs wide apart; or legs extend, one foot straight, one everted.	Upright posture; legs extend in line with trunk, wide apart, feet straight.

* The mean—normative—age for independent standing is 56 weeks; for independent walking, it is about 62 weeks.

hand preference. In a typically right-handed child [see (8)] we have observed alternations as follows:

Around 16 to 20 Weeks

When first hand contact with objects occurs, this contact may be with the left hand, possibly because a right-handed infant may still be showing remnants of a typically right-tonic-neck reflex, which extends the right arm and brings the fisted left hand (because of left-arm flexion) closest to an object which is presented to the child.

24 Weeks

After the tonic-neck reflex wanes, around 24 weeks, most right-handed children seem to go through a brief bilateral stage.

28 to 32 Weeks

A period of transfer of objects. Infants use hands alternately. However one hand is used at a time, the right most, though left hand has its turn.

32 to 36 Weeks

A second period of bilaterality.

40 to 44 Weeks

A strong unilateral, right-handed period.

48 Weeks

Unilateral and in many a left-handed period.

52 to 56 Weeks

Right handedness prevails.

18 Months

In many, a period of unilateral use of the nondominant (left) hand.

2 Years

Right handedness in most, and in some it appears to be established at this age. (In others, further periods of bilaterality and left handedness continue to alternate with right handedness.)

2½ Years

Bilateral behavior in many.

3 Years

Unilateral right handedness.

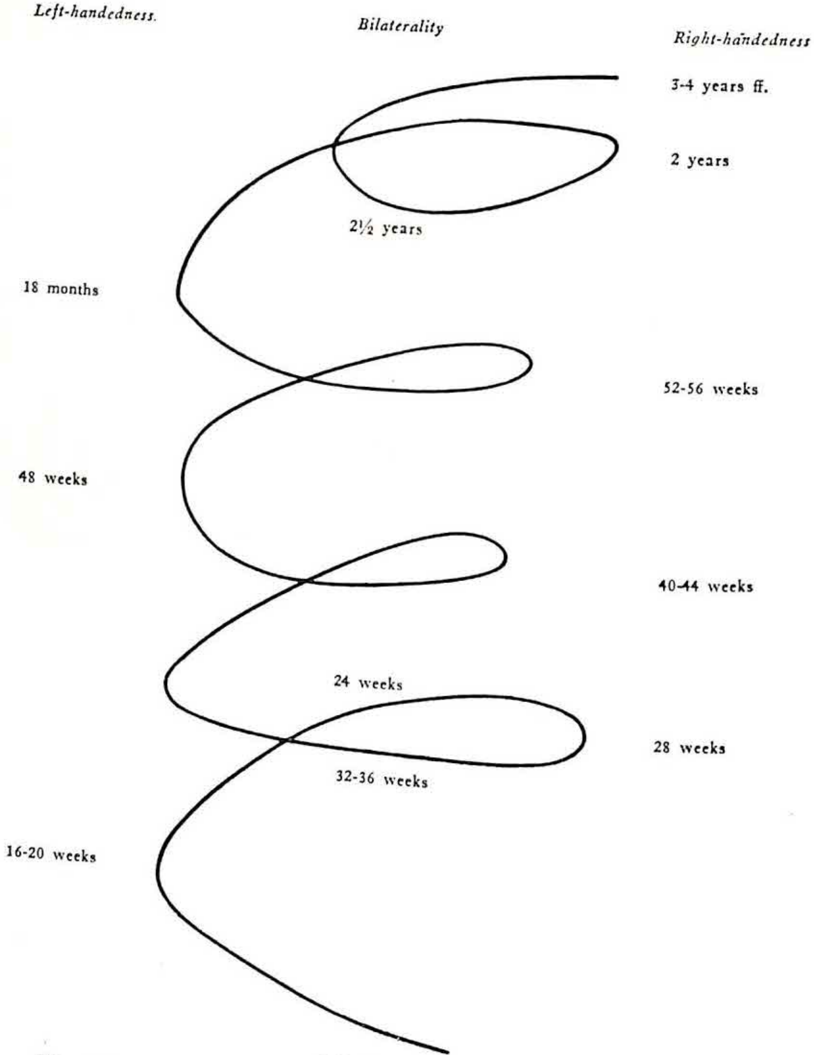

FIGURE 2

Typical Age Changes in Handedness in a Right-Handed Child

If nature is working out something so complex, it seems obvious that, in all probability, best results will be obtained if parents do not interfere with the child's natural expression of handedness other than, perhaps, to present objects nearest to his right hand. And, if the path that leads toward eventual dominance of the right hand is so complex and intricate (even in potentially fully right-handed children), obviously it is even more complex and intricate in children who seem more naturally endowed with ambidexterity.

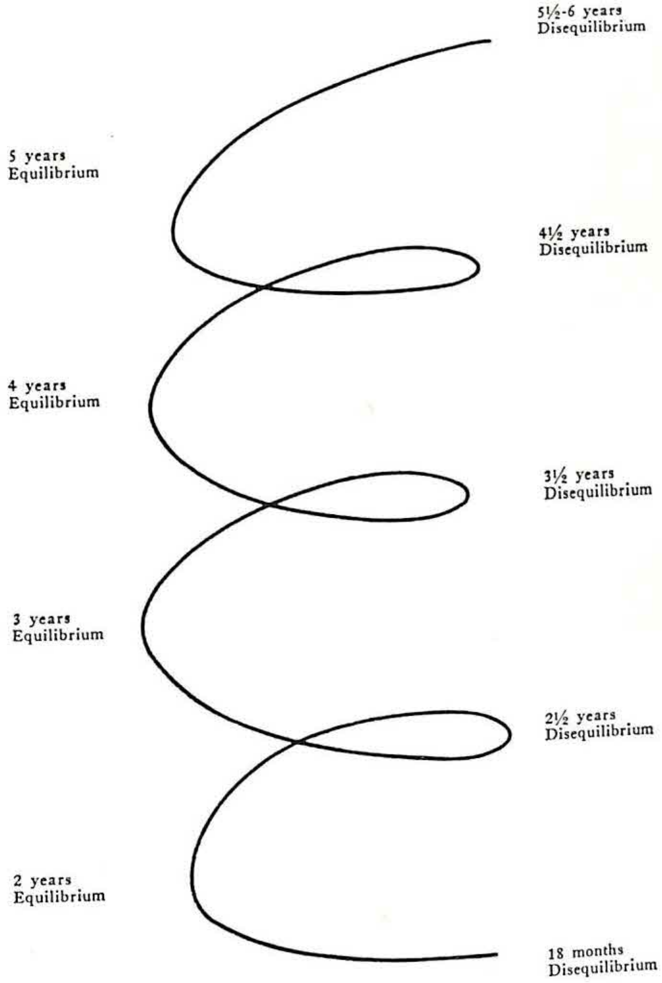

FIGURE 3
AGES OF EQUILIBRIUM AND DISEQUILIBRIUM

Though many parents exhibit a strong tendency to influence and to determine handedness in their children, some are able to remain fairly objective and noninterfering and are able to observe the interweaving of the various types of handedness response (right, left and ambidextrous) with some degree of neutrality, realizing that the tendency to respond in one or the other of these ways does come largely from within.

c. Ages of equilibrium and disequilibrium. When the two strands of behavior that are interweaving are tendencies to equilibrium and disequilibrium of response, it is difficult for most parents to remain objective and it is natural for them to seek an "environmental" explanation of behavior. The "good" child is suddenly "bad." Something, parents say to themselves, must have caused the bad behavior.

Nevertheless, the marked similarity in behavior changes with age that are observed in many children has led us to believe that forces of reciprocal interweaving may play a vital part even in an area as global as the total way a child responds to the world about him.

We have earlier observed (9) that a child's behavior at any given age seems to consist of more than the sum of the things he is able to do. Behavior at any given age seems almost to have an individuality of its own, reflecting the stage of growth that the child has reached. There are some ages that, in the majority of children, seem to be characterized by a general equilibrium, an easy adaptation to environmental factors and the demands of daily living.

Other ages are just the opposite and seem characterized by a general disequilibrium. At such ages all areas of living may be affected and the child may have trouble with eating, sleeping, response to other people, and to life in general.

Though such alternations or interweavings of ages of equilibrium and disequilibrium may be observed even in infancy, we have not as yet worked out their course in final detail. However, from 18 months through 5½ to 6 years (a period when understanding of what is going on within the child is most important for parent and specialist), we can chart these alternations clearly, as Figure 3 shows. Briefly described, age expectations in general (and any child of course may be ahead of or behind this timetable) are as follows:

18 Months

The 18-month-old child walks down a one-way street, and this street more often than not leads in a direction exactly opposite to that which the adult has in mind. It is difficult for the child to mind when spoken to, to respond to commands, to keep within reasonable bounds. And he is extremely strong-willed. His immaturities in motor, adaptive, language, and emotional fields may lead to tantrums. This is a marked stage of disequilibrium in many children.

2 Years

Things are much smoother in nearly every field of behavior. Added maturity and a calm willingness to do what he can do and to not try too hard to do things he cannot manage result in rather good equilibrium. The child is now surer of himself both motorwise and languagewise. Emotionally, too, he finds life easier (as his demands are not so strong as earlier), and he has developed an ability to wait and to suffer slight or temporary frustration if need be.

2½ Years

This is an age of marked disequilibrium. The child of this age tends to be rigid and inflexible—he wants exactly what he wants when he wants it. Everything has to be in what he considers its proper place, everything done exactly so. He sets up rigid routines which he expects everyone to follow. Furthermore, he is domineering and demanding. *He* must make the decisions. His emotions are violent. And, most of all, this is an age of opposite extremes. The child has no ability to choose between alternatives; so he shuttles back and forth endlessly between any two extremes: "I want—I don't want"; "I will—I won't."

3 Years

Things quiet down briefly at 3 for most children. Whereas the 2½-year-old loved to resist, Three loves to conform. The child now likes to give as well as take. He likes to cooperate. He wants to please. He seems to be in good equilibrium not only with those about him but within himself. People are important to him and he likes to make friends. His increased language ability allows him to enjoy language and to respond well to language cues.

3½ Years

In many, there is even more marked disequilibrium than at two-and-a-half. The child at this age exhibits an extremely strong will, and any sort of compliance is hard to obtain. He may resist any and every routine. He insists on having his own way and seems to resist for the sheer pleasure of resisting. Though quite unwilling to please, he is emotionally very vulnerable and is quick to question "Do you love me?" He cannot stand to be ignored; but too much attention, also, disquiets him: "Don't laugh!" he commands.

4 Years

This is an expansive, out-of-bounds age. Motorwise the child may hit, kick, throw stones, break things, run away. Emotionally he exhibits loud silly laughter or fits of rage. Verbally he is extremely out-of-bounds; he lies, swears, boasts, resists. He loves to defy parental commands and seems to thrive on punishment. A terrible toughness comes over many: they swagger, swear, boast, defy. And yet within himself the child of this age does not seem to be in any great trouble, and he can be quite delightful and enjoyable in spite of his out-of-bounds qualities.

4½ Years

Half way between Out-of-Bounds Four and Calm Five, the child of this age often doesn't seem to know where he is functioning and, as a result, his behavior can be extremely variable and unpredictable. It is this extreme variability and unpredictability that makes life difficult for the child himself and for those around him.

5 Years

A period of extreme and delightful equilibrium. The child of this age tends to be calm, stable, reliable, well adjusted. He is friendly and undemanding with others. He loves to please. His mother seems to be the center of his world and he likes to be with her, to do what she asks, to please her. "Today I'm going to do all of the good things and none of the bad things," a 5-year-old will say. Five likes to be instructed and to get permission and then to obey. He likes to help. Briefly he is a delightful social being.

5½ to 6 Years

Equable Five is followed by Tumultuous Six, the breakup starting around 5½. Behavior resembles that seen at 2½ in that the child is violently emotional and tends to function at opposite extremes: "I love—I hate." He himself is now the center of his own world and he wants to be loved most, to be first, to have everything. When anything is wrong he blames his mother and takes things out on her. He cannot stand to lose, to take his turn, to share. He has to be right, needs to win, demands praise. If things go well he is warm, enthusiastic, eager, ready for anything. If they go badly, he resorts to tears and tantrums.

d. Cycles of behavior. Though it does seem possible, at least during the first six years of life, to characterize alternating stages of behavior as equilibrated or disequilibrated; other forces appear to be at work. The most conspicuous of these is a tendency, at successive stages, for behavior to be either expansive or pulled in. Both of these sets of factors must be considered if we are to attain a long-range view of the kinds of behavior that may be expected as the child matures.

Not only do equilibrium and disequilibrium and "inwardizing" and "outwardizing" factors seem to alternate at successive and adjacent age stages, but a rather complex cycle of behavior-stages that we have identified as occurring between 2 and 5 years seems to repeat itself twice more in the years from 5 through 16.

The ages of 2, 5, and 10 constitute focal points at which behavior seems to be in good equilibrium, the child having relatively little difficulty within himself or with the world about him. Each of these relatively smooth and untroubled ages is followed by a brief period when behavior appears to be very much broken up, disturbed, and troubled, and when the child shows himself to be in marked disequilibrium. Thus the smoothness of 2-year-old behavior characteristically breaks up at 2½, 5-year-old behavior breaks up at 5½ to 6, and 10 breaks up at eleven—the 11-year-old child characteristically showing himself to be at definite odds with his environment and with himself.

Each of these ages is followed, once more, by a period of relative equilibrium at 3, 6½, and 12 years, respectively, when life's forces seem to be in good balance. The child is happy both within himself and in his environment.

These are followed by ages when there is a very pronounced "inwardizing" or drawing in of outer impressions and experiences to be mulled over, thought about, and digested. These ages are 3½, 7, and 13 years. At 3½ this inner process often has disturbing side effects: general emotional instability, a variety of fears, poor spatial orientation, hand tremor, a whining and highly tremulous voice, stuttering, and stumbling. Seven and 13 are more stable ages and better ready to stand the strain of this "inwardizing" period of growth. The side effects at these latter ages are more apt to be expressed in marked sensitivity and touchiness, in excessive withdrawal and moroseness, and in a minor and pessimistic attitude toward life in general.

Each of the three ages just mentioned (3½, 7, and 13) is followed by a period of extreme expansiveness. Four, 8, and 14 are times at which the child's behavior is markedly outgoing in most major respects. He is even in danger of expanding too much. He wanders from home and gets lost at 4, he demands to ride his bicycle in the street at 8 and may get hit, and he gets all tangled in his multiple and conflicting social plans at 14.

The next three ages (4½ years, 9, and 15) are ages about which we perhaps know the least, but we do know enough to recognize certain similarities about the three periods. In each, behavior is less outgoing than at the age that directly preceded it. In each it is in less good equilibrium. Child specialists have frequently described each of these ages as "neurotic," though each may represent a perfectly normal stage of growth, and when behavior takes a positive turn at any of these ages it can be unusually positive and productive.

Then, once more in each instance, we come to an age of stability and of relatively good equilibrium: 5, 10, and 16.

A brief and schematic tabular presentation of the age changes from 2 years on, as described above, is given in Table 2.

TABLE 2

Ages			Behavior
2	5	10	Smooth, consolidated.
2½	5½–6	11	Breaking up.
3	6½	12	Rounded—balanced.
3½	7	13	Inwardized.
4	8	14	Vigorous, expansive.
4½	9	15	Inwardized-outwardized, troubled, "neurotic."
5	10	16	Smooth, consolidated.

B. Summary

According to the devolpmental point of view, behavior in the human infant and child develops in a patterned, orderly manner, through stages that are largely predictable and similar from child to child as to their content and timing. Two of the outstanding laws or rules of development are (*a*) the principle of cephalocaudad development and (*b*) the principle of reciprocal interweaving. According to the first, we find that behavior in the human organism develops chiefly in a head-to-foot direction. According to the second, in any growing behavior (or area of behavior) it is possible to identify paired-but-opposed types of response that occur in repeated alternation until the behavior has reached its final or complete stage, spiralling upward as it progresses.

Thus behavior does not simply develop in a straightline direction, the immature gradually and without lapse giving way to the mature; but, rather, if one of these opposites can be identified as immature and the other as mature (as is usually the case), we must anticipate repeated recurrences of the more immature behavior alternating with the more mature as the child grows older.

In such an area as prone progression, where the chief alternating behaviors are flexion and extension, the adult as a rule can view these alternations objectively. In such an area as handedness (where the responses alternating may be right handedeness, left handedness, and bilaterality), the adult is more likely to be inclined to step in, too soon, to try to influence behavior.

In such an emotionally toned area as the child's response to his mother or his total response to life situations in general, where the two factors that alternate and interweave are a basic disequilibrium and a basic equilibrium, it is more difficult for the adult to remain objective. Knowledge of approximately when to expect recurring stages of disequilibrium, and an appreciation of the fact that a total disequilibrium of response may be expected to characterize certain age levels (regardless of the excellence of environmental conditions or of parental handling) can be useful to the parent in guiding the child, and to the pediatrician in guiding the parent.

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A COMPARATIVE STUDY OF THE WAIS PERFORMANCE OF NATIVE-BORN NEGRO AND WHITE HOMELESS*

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A. Introduction

We have recently become interested in the hypothesis that homeless men, no matter what their backgrounds may have been, have certain aversive learning experiences in common (11). These experiences in turn lead to the development of some common personality traits. Clinical evidence indicates that a person's performance on a test of mental ability is related to his personality characteristics. Witkin (20), for example, finds that field-dependent examinees receive significantly lower scores on Block Design, Picture Completion, and Object Assembly than field-independent subjects. We decided to study the Wechsler Adult Intelligence Scale [WAIS (19)] psychometric patterns of diverse groups of homeless men to see if we could find evidence to support our hypothesis.

The homeless group represents a conglomerate section of the population, and the problem arises as to how (on the WAIS) one can tease out the personality concomitants of homelessness from the effects of a very poor cultural status and, possibly, from alcoholism—also from "race," as we were concerned with both white and Negro subjects (13).

We wish to stress that, at no point, did we try to determine the intelligence of the Negro homeless. This is an impossible task, with the available tests of mental ability. Further, we made no attempt to equate the performance of the Negro homeless on WAIS with intellectual functioning or to consider them causative factors of their present status. We merely sought to learn how functioning (by these men) on the WAIS compares with that of white, homeless men who are in the same predicament. To begin, we hypothesized that the *IQ* of homeless Negroes would be similar to that of the general Negro population. The psychometric pattern, however, would be influenced by the homeless status and possibly by pathology. We also hypothesized that (while the subtests for the Negro and white samples may be quantitatively different), qualitatively they would be similar and would show similar high and low

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subtest scores. The problems, therefore, were as follows: (*a*) What is the WAIS performance of native-born homeless Negro men? (*b*) What differences are there in the WAIS patterns of the Northern-born as compared to the Southern-born Negro homeless? and (*c*) What similarities, if any, are there in the psychometric patterns of the native-born Negro and white homeless men?

B. PREVIOUS RESEARCH

Comparatively few psychological studies have been made of homeless men (7). The studies made up to 1944-1945 indicated that below-average intelligence was thought to be one of the factors that accounted for their homeless state (7). However, subsequent research has not supported these findings. On the whole, subsequent research has demonstrated that either above- or below-average performance on tests of mental ability is found in homeless men on Skid Row. Thus, the native-born white homeless man's full-scale Wechsler-Bellevue (WB) *IQ* of 100.9 (7), or full-scale Wechsler Adult Intelligence Scale (WAIS) *IQ* of 96.8 (9), is comparable to that of the general population. The Wechsler-Bellevue *IQ* of 88.5 for foreign-born homeless men (7), while below average, is on par with that of the New York City foreign-born population. The non-Negro Puerto Rican homeless has a prorated *IQ* of 75.8, which is difficult to evaluate because comparable data for a New York City Puerto Rican population are not available (2). The homeless Jews have a full-scale WAIS *IQ* of 85.6, which is below the mean for the New York City Jewish population (8).

While there is a wealth of data regarding the performance of Negroes on tests of mental ability (3, 14), no study has been found of the performance by Negro homeless on the WAIS. Previous studies indicate that, by and large, Negro test scores are below those of the white, and that the Northern Negro has a higher score on mental ability tests than does the Southern Negro (14). Machover (12) matched two groups of Negro criminals—Southern (no more than four grades in school) and Northern—on the composite of raw scores of two Wechsler-Bellevue subtests: Similarities and Comprehension. He found that the Southern Negroes excelled in Verbal Comprehension and in Similarities and were inferior in Digit Symbol, in Block Design, and in Picture Arrangement. Another study (16) compared the performance of Negro children—Southern and Northern—on the Wechsler Intelligence Scale for Children. There was a statistically significant difference between the Verbal and Performance *IQ*s for the Southern children, in favor of the Verbal *IQ* (Verbal, 80.3; Performance, 68.8), but not for the Northern children (Verbal, 87.4; Performance, 88.4).

C. METHOD

The selection of a representative group of homeless men is a difficult task, as the characteristics of the men who come for assistance to a private or public agency depend so much upon the season of the year, the weather, the day, and even the time of the day. We made this study in the late spring and summer of 1962. We attempted to secure a stratified sample by examining some men on weekends, some on weekday mornings, and some on afternoons.

Supervisors from the New York City Department of Welfare informed us that the total homeless caseload at the time of our study fluctuated around 900. It is to be noted that it is illegal to indicate the race of the applicant on the registration cards or to keep any statistical records as to the racial composition of the case load. The supervisors' educated guess was that Negroes comprised about one third of the total and that one per cent of the Negroes were foreign born.[1] The subjects were selected while standing in line and waiting to be registered for service. We explained to potential subjects that we were conducting a research study and asked them to volunteer. At the end of the examination, each man usually received a package of cigarettes. We approached 37 Negro men and 32 were able and willing to cooperate. Thus, we secured a 10 per cent sample and feel that it is fairly representative of homeless Negroes at the time the study was made. However, in considering the validity of the results, one must keep in mind that the performance of the men was undoubtedly influenced by the fact that the examiner was a white man (5).

D. RESULTS

Our sample consisted of 32 cases. Their full-scale WAIS *IQ* was 83.78 (*SD*, 18.52), their Verbal *IQ* was 85.91 (*SD*, 18.34), and their Performance *IQ* was 82.31 (*SD*, 18.92). Nine men were born in the North (mean *CA*, 31.11; *SD*, 5.92). The mean full-WAIS *IQ* of the men was 91.11 (*SD*, 20.19), the mean Verbal *IQ* was 93.11 (*SD*, 18.63), the mean Performance *IQ* was 89.67 (*SD*, 22.27). Six men had a full WAIS *IQ* of over 90 and three had a full WAIS *IQ* below 90. Twenty-three men were born in the South (mean *CA*, 36.87; *SD*, 8.68). The mean full WAIS *IQ* of the Southern men was 80.91 (*SD*, 17.18), the mean Verbal *IQ* was 83.09 (*SD*, 14.12); the mean Performance *IQ* was 79.43 (*SD*, 16.58). Eight men had a full WAIS *IQ* over 90 and 15 had a full WAIS *IQ* below 90.

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[1] This compares with an estimated nine per cent of Negro residents in the Chicago Skid Row (18), 14.7 per cent in Philadelphia, and four and one-half per cent in Minneapolis (17).

The sample of white homeless men was the one previously described by Levinson (9). The mean *CA* of the white homeless was 48.49 (*SD*, 8.30). The mean *CA* of the Negro homeless was 35.25 (*SD*, 8.49).[2] The difference in age between white and Negro homeless is significant at the .01 level of confidence. This confirms previous research findings (17, 18) and may indicate that the reasons why Negroes come to the Men's Shelter are somewhat different than those of the whites.

Table 1 presents a comparison of the psychometric patterns of the Negro and white homeless. There are significant differences at either the .05 or .01 level of confidence on all tests except Object Assembly. In the subtest, the Negro subjects did slightly better than the whites.[3] The superior performance of the white homeless men follows previous findings. However, we were puz-

TABLE 1

SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE MEANS OF THE WAIS SUBTESTS* OF THE NATIVE-BORN NEGRO AND WHITE HOMELESS

Test	Negro (N = 32) Mean	*SD*	White (N = 50) Mean	*SD*	Difference	*SE*	*t*
WAIS							
Full *IQ*	83.78	18.52	96.79	11.33	13.01	3.70	3.52++
Verbal *IQ*	85.91	18.34	101.30	12.31	15.39	3.75	4.10++
Performance *IQ*	82.31	18.92	91.62	10.90	9.31	3.74	2.49+
Verbal tests							
Information	7.88	4.44	10.51	2.29	2.63	.85	3.06++
Comprehension	7.81	4.18	10.50	3.26	2.69	.88	3.06++
Arithmetic	6.56	3.91	10.31	3.54	3.75	.87	4.31++
Similarities	7.03	4.08	9.47	3.19	2.44	.87	2.80++
Digit Span	8.13	2.15	10.32	2.57	2.19	.54	4.06++
Vocabulary	6.66	4.72	10.86	2.78	4.20	.94	4.47++
Performance tests							
Digit Symbol	6.28	3.07	7.59	2.01	1.31	.62	2.11+
Picture Completion	6.94	3.27	9.78	3.08	2.84	.73	3.89++
Block Design	6.89	3.35	8.54	2.65	1.66	.71	2.34+
Picture Arrangement	7.53	3.76	9.07	3.00	1.54	.80	1.93
Object Assembly	7.66	2.98	7.45	2.01	—.21	.60	0.35

* Based upon age-scaled scores.
+ Significant at the .05 level of confidence.
++ Significant at the .01 level of confidence.

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[2] Generally speaking, the Negro homeless tends to be younger than the white homeless. Thus (in Philadelphia) it was found that over 40 per cent of the homeless Negroes—as compared with less than 25 per cent of the white homeless—were below 45 years of age (17, p. 5).

[3] Wechsler has also noted that "It (Object Assembly) runs with the hares and hunts with the hounds. . . . It correlates least with *g* and is systematically low with all the Subtests of the scale" (19, p. 134).

zled over the fact that the psychometric pattern of the homeless Negroes did not duplicate that found in the Machover Study (12) or in the Teahan and Drews Study (16). We then thought that (possibly) our findings were either a function of the higher level of schooling of our group or of the higher *IQ* which is significantly higher than the one reported in the two studies just mentioned. In considering the matter further, we arbitrarily decided to consider an *IQ* of 100 as the breaking point below which the effect of aversive learning experiences should be most apparent. The number of years of schooling might have been a better criterion, but for the fact that it was a variable and unverifiable quantity. (Four years of schooling in one state might have been equivalent to one year in another).

TABLE 2

THE WAIS SUBTESTS OF HOMELESS NATIVE-BORN NEGROES WHEN FULL-SCALE WAIS SCORES ABOVE 100 ARE EXCLUDED*

($N = 26$)

Test	Mean	*SD*
Full Scale	77.31	14.32
Verbal Scale	79.19	12.04
Performance Scale	76.73	16.22
Verbal tests		
Information	7.15	2.89
Comprehension	6.46	2.79
Arithmetic	5.31	3.36
Similarities	5.50	3.86
Digit Span	7.58	1.85
Vocabulary	5.65	2.82
Performance tests		
Digit Symbol	5.35	2.59
Picture Completion	5.88	2.50
Block Design	6.04	3.03
Picture Arrangement	6.73	3.59
Object Assembly	6.96	2.78

* Based upon age-scaled scores.

We had a total of 26 cases: Five Northern and 21 Southern. The mean *CA* for this group was 34.92 (*SD*, 8.96).

Table 2 shows the psychometric patterns of the homeless Negroes when *IQ* scores above 100 are excluded. Again note that the psychometric pattern does not corroborate that found in previous studies.

Table 3 shows the WAIS subtests of the Northern and Southern Negroes. In view of the paucity of cases, it is pointless to compute critical differences.[4]

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[4] As the reader may note, we attempted to use the simplest possible statistics for (in our opinion) using refined statistics on a small and possibly unrepresentative sample is like trying to kill a sparrow with a hydrogen bomb.

Note, again, the same phenomenon. It is our belief that the difference between the performance of Northern and Southern Negroes on tests of mental ability is not due to the state of origin, but is due to the cultural and educational stimulation received. Possibly, our Southern subjects were able to overcome poor cultural and poor school opportunities by wider travel, which travel may have served as a cultural leaven and thus may have affected psychometric patterns [See (6)].

TABLE 3

The WAIS Subtests* of the Southern and Northern Negro Homeless

Test	Northern ($N = 9$) Mean	*SD*	Southern ($N = 23$) Mean	*SD*
Verbal tests				
Information	8.33	3.63	7.70	4.43
Comprehension	10.00	4.44	6.96	3.73
Arithmetic	8.33	3.41	5.87	2.70
Similarities	7.56	4.29	6.83	3.97
Digit Span	8.55	2.96	7.96	1.66
Vocabulary	7.44	4.07	6.35	3.23
Performance tests				
Digit Symbol	6.78	3.99	6.09	2.74
Picture Completion	8.77	3.81	6.22	2.75
Block Design	8.67	3.15	6.17	3.19
Picture Arrangement	7.78	4.36	7.34	3.66
Object Assembly	8.67	3.26	7.26	3.12

* Based upon age-scaled scores.

At this point we decided to see if there were any similarities in the psychometric patterns of the white and Negro homeless. We computed the rank-difference correlation (based upon the data in Table 1) and found it to be .65, which is significant at the .02 level of confidence. Another computation of the rank-difference correlation (based upon the data in Table 2) indicated it to be .87, which is significant at the .01 level of confidence.

E. Discussion

When we analyze the nature of the tasks involved in verbal and performance tests, we note that performance tests (in contrast with verbal tests) usually "demand a longer period of sustained attention" and "depend less on habit and more on ability to attack a new problem" (1). A Negro child, no matter how he may be deprived culturally, still has many opportunities to exercise his verbal abilities. He engages in much verbal play. However, he has very few toys, if any. He is exposed to large objects in his environment and he is not rewarded for developing the ability to note small differences. Thus, he learns to evaluate objects not through emphasis on perceptual observation but through emphasis on verbal clues. A shift to performance tasks would mean a reorientation and a new learning experience. This is difficult to accomplish on the spur of the moment, particularly when one is faced with a task having time elements.

Another factor to be considered is the possibility that the status of being homeless may also indicate a withdrawal from reality, which withdrawal may produce the differences between the verbal and performance areas. To secure a satisfactory rating on performance tasks, one must exercise an active effort which is not as necessary in verbal problems. Furthermore, the Negro and white homeless may have internalized similar values which values, in turn, may have influenced their respective psychometric patterns (10). Possibly, both homeless groups may be more field dependent than the domiciled population—thus bringing about a significant lowering of the performance-test scores (20). The two groups may also be subject to common organic dysfunction, which dysfunction may have similar effects on their WAIS performance. It is evident that the similarities of Negro and white psychometric patterns support our hypothesis of possible common aversive learning experiences, but they do not prove it.

This study appears to have other theoretical implications. With the discrediting of psychometric patterns as indicators of psychopathology (1), we find an increasing number of studies that try to resurrect this concept under a new guise (4, 15). Apparently, some clinicians (like the Bourbons) never learn or forget. Research findings do indicate that "patients with predominantly left-hemisphere lesions" show impairment on verbal subtests, those with predominantly "right-hemisphere lesions" show impairment on performance subtests, and those with "diffuse or bilateral cerebral damage" show no difference between verbal and performance subtests. However, these findings cannot be used in diagnosis (without other confirming evidence) because so many nonorganic groups can show similar patterns.

F. SUMMARY

A study was made of the performance on the Wechsler Adult Intelligence Scale of a random sample of 32 native-born Negro homeless. Their full-scale WAIS *IQ* was 83.78 (*SD*, 18.52), their Verbal *IQ* was 85.91 (*SD*, 18.34) and their Performance *IQ* was 82.31 (*SD*, 18.92). The psychometric pattern of these men was similar to that obtained for a white homeless group. It is felt that possibly both groups had common aversive learning experiences that may account for the similarities in the WAIS patterns.

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DOMINANCE BEHAVIOR OF THE RAT: A DEMONSTRATION OF THE FUNCTIONS OF GENETIC STRAIN*

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A. INTRODUCTION

This investigation constitutes the second in a series of studies dealing with possible genetic differences in the emotional and social behavior of two strains of domesticated laboratory rats. In a previous article (4), it was reported that Wistar albino rats do not differ significantly in timidity or in aggressiveness from the nonagouti black-hooded strain. The purpose of the present study is to determine whether there are any genetic differences in social dominance between these two strains of rats. Dominance refers to behavior that can be elicited only when (*a*) there is competition between two organisms for some goal object, (*b*) the need or drive activating the animals is congruent with the goal object, and (*c*) the need or drive can be satisfied by only one of the partners at a given time (3).

B. METHOD

1. *Subjects*

Fifteen male Wistar albino rats (cc HH aa) and 15 male black (nonagouti) hooded rats (CC HH aa) served as subjects. They were housed in individual cages and were maintained on an *ad libitum* diet of food and water from 21 to 63 days of age.

2. *Apparatus*

The Dominance Test Box was a 48″ × 15″ × 12″ black, wooden box with a wire-mesh lid. A starting cage was placed at the right end of the box. This cage had a guillotine door that could be raised vertically through an opening in the wire-mesh lid. A metal feeding cylinder, 2¼″ high and 1¼″ in diameter was fastened to the floor in the center of the box.

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* Received in the Editorial Office on December 3, 1962. Copyright, 1964, by The Journal Press.

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3. *Procedure*

The experiment was divided into two distinct phases: familiarization and the dominance test.

a. Familiarization. When *S*s were 63 days of age, all food was removed from their cages. They were given a single one-hour feeding daily of food mash. Water was *ad libitum.*

This period provided a transition to the dominance-test period during which *S*s were required to fight for control of and to eat from the feeding cylinder of the Dominance-Test Box. It also allowed the rats to explore and become familiar with the inside of the apparatus. Each rat was given a single five-minute trial daily for 18 consecutive days, starting at 65 days of age.

Five seconds after being placed inside the starting cage of the apparatus, the guillotine door was raised and *S* was permitted to enter the box and to eat from the cylinder. *S*s were provided with their regular one-hour feeding at the completion of all daily trials.

b. Dominance Test. Dominance testing commenced when *S*s were 83 days of age and ended 15 days later. Each hooded rat was paired once with every albino rat. Because it was paired once daily, each *S* had a total of 15 different pairings during this period. There were 15 different competitions daily for a total of 225 during the entire testing period.

Five seconds after each pair of competitors was placed inside the starting cage of the Dominance-Test Box and the wire-mesh lid was lowered, the guillotine door was raised and *S*s were permitted to race toward the feeding cylinder. During the five-minute competition, the time (in seconds) that each rat spent eating was recorded on individual timers. As the opening of the feeding cylinder was only 1¼″ in diameter, only one *S* at a time could eat from it.

*S*s were given their regular feeding of mash at the end of all daily competitions. Water was *ad libitum.*

C. RESULTS

The total time each *S* spent in eating from the feeding cylinder during all its pairings was divided by 15 to yield a mean dominance-time score for each *S*. These were then averaged for the two strains. Table 1 shows the group means and standard deviations. As will be seen, the black hooded rats dominated the feeding cylinder for considerably longer than the Wistar albino rats, and the difference between the group means is significant ($t = 6.32$, $p < .01$).

TABLE 1
MEANS AND STANDARD DEVIATIONS OF DOMINANCE-TIME SCORES FOR BLACK HOODED AND WISTAR ALBINO STRAINS

Strain	*N*	Mean time in seconds	*SD*
Black hooded	15	152.0	51.75
Wistar albino	15	47.6	33.74

D. DISCUSSION

This experiment has clearly demonstrated that black (nonagouti) hooded rats are significantly more dominant in competitive feeding situations than those of the Wistar albino strain. It has already been shown that no significant difference in agressiveness exists between these two strains (4). These results provide further support for the position that aggression and dominance represent two distinct patterns of social behavior and that any positive relationship between the two may be species-specific (5).

Although a significant difference in dominance between these two rat strains has been shown it is necessary, from the standpoint of behavior genetics, to relate these differences to other possibly existing behavioral, physiological, or biochemical differences (1). It can be hypothesized that the differences in dominance may be related to such inherited behavioral differences as emotionality or fearfulness, exploratory behavior, or learning ability.

In terms of known physiological differences between these two strains (such as the absence of pigment from the iris and retina of the albino rat), Keeler (2) has suggested that the flashing of images upon the albino retina may possibly create a state of "confusion," especially when the albino rat is confronted by a hooded rat which possesses superior visual acuity. Because this study was conducted under well-illuminated conditions, it is conceivable that the albino rats were more "bewildered" than the hooded *S*s, during the feeding competitions.

Further research to determine the genetic basis of these differences in dominance might, as Keeler (in a personal communication) has proposed, consist of crossing the albinos with the black hooded rats, then back crossing the black hooded hybrids to the albinos. An examination of these offspring might possibly reveal whether the dominance tendency is associated with albinism or its color allele.

E. SUMMARY

This experiment has demonstrated that, in competitive feeding situations, male rats of the black (nonagouti) hooded strain (CC HH aa) are signifi-

cantly more dominant than those of the Wistar albino strain (cc HH aa). These differences in dominance can be attributed solely to differences in genetic background because both strains were given the same treatment during the course of the study. It is proposed that the differences in dominance may be related to the superior visual acuity of the hooded rats; thus making them less "confused" and "bewildered" than the albinos, during the feeding competitions. Recommendations for further research in terms of genetic analysis of the dominance tendency are outlined.

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SOCIAL REINFORCEMENT OF BAR PRESSING IN MICE*[1]

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A. INTRODUCTION

Studies have now established the fact that normally reared rats and mice of laboratory strains manifest adient reactions toward other animals of the same strains (1, 3, 4). The stimuli that mediate such reactions, however, have not yet been clearly identified. The results of available studies do not make it possible to specify which aspects of social stimulation mediate approach behavior because, in these studies, stimulus animals have been presented behind grills or wire screens; thus providing complex combinations of socially mediated visual, auditory, olfactory, and other cues. Consequently, Angermeier's conclusion (1) that visual social stimulation alone suffices to reinforce the bar pressing of normally reared rats may be questioned.

In studies of the effects of social stimulation, a methodological difficulty that has been recognized only by some workers (6) is that the introduction of a stimulus animal into the environment of the subject provides not only social stimulation; but also provides increased stimulation of a more general nature, the effects of which may be interpreted in terms of "sensory reinforcement" (5) rather than in terms of "social reinforcement." For this second reason, studies that have not employed controls for the possible sensory reinforcing effects that arise from the operation of the test apparatus and from the *change* in stimulus pattern when a stimulus animal is introduced (1, 2) are better regarded as pioneering attempts to analyze the effects of socially mediated stimuli and as sources of hypotheses rather than as finished analyses of the reinforcing properties of discrete aspects of social stimulation.

The present study, which employed a specially designed stimulus-display and bar-press apparatus and used eight groups of mice in a factoral design, was conceived as an attempt to assess the degree to which the visual aspect alone of the pattern of stimulation provided by an active stimulus mouse might serve to reinforce the bar pressing of another mouse. The experimental design

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provided for determination of the effectiveness with which the apparatus restricted social stimulation to the visual dimension and for comparison of the reinforcing effect of response-contingent visual presentation of a stimulus-mouse with the sensory reinforcing effects of visual presentation of the empty display compartment and of a mouse-size black block situated within the display compartment. The procedure also involved a yoked-control arrangement so that some subjects were presented with either social or nonsocial visual stimulation on an intermittent, nonresponse-contingent basis. This latter yoked-control provision of the procedure was included to permit an indication of the extent to which increased responding in the presence of a given visual stimulus is a unique function of the contingency of presentation of that stimulus on the bar-press response.

B. SUBJECTS

The subjects were 64 experimentally naive mice (32 males and 32 females) of the homozygous C57 Black Subline 6 Strain. Between the time when they were weaned (at 29 to 32 days of age) and the time when they were tested (at 44 to 56 days of age), the subjects were maintained in one-sex groups with free access to food and water in communal hardware-cloth cages.

C. APPARATUS

The test apparatus for this study provided for instantaneous presentation and removal of visual-social and other visual stimuli in a glass-faced display compartment situated immediately behind a response bar in a work compartment. The apparatus was designed so that under conditions of total darkness the subject in the work compartment would be unable to see into the display compartment. Illumination of the interior of the display compartment, however, immediately rendered a stimulus mouse or other object in that compartment visible to the subject in the work compartment. The use of a glass pane in lieu of a wire screen or grill between the two compartments (along with procedural controls) was expected to limit to the visual component the stimulation provided by a stimulus mouse in the display compartment. That the apparatus functioned to restrict stimulation to the visual aspect was borne out by the results.

Two identical two-compartment apparatus units were used. The work compartment of each unit, made of plywood and painted with a medium-gray, semigloss enamel, was 6″ long, 6″ wide, and 5-1/2″ high on the inside. In one of the walls a 2-3/4″ by 2-3/4″ central opening was provided. The lower edge of this opening or window was 7/8″ above a 1/4″ mesh, hardware-cloth floor. At the center of the basal edge of this wall, a slot (1/2″ wide) allowed insertion of the stem on which the response bar was mounted. The compartment was provided with a removable, light-tight, wood top.

Each of the two apparatus units was equipped with a response bar made of aluminum stock materials. This bar was T shaped, the crosspiece or bar being a 2-3/4″ section of storm-screen spline. When mounted on the work compartment, the crosspiece was parallel to and 1/2″ away from the lower edge of the window opening to the display compartment. A downward pressure of 2.2 ± .1 gm through a distance of 3/16″ effected closure of a Unimax snap-action switch, by the pivoted stem of the T outside the work compartment.

The display compartment of each unit was mainly of plywood construction and consisted of two sections: namely, a lower display compartment proper measuring 3-1/2″ long, 3″ wide, and 2-7/8″ high, and an upper-light housing. The two sections were divided by a pane of frosted glass. The lower display section, open at one end, was designed for insertion into a wider square recess around the window opening in the wall of the work compartment. A pane of clear glass fitted into the recess to separate the display and work compartments. Except for the glass, the interior of the display compartment was painted with a semiglossy, white enamel. For ventilation purposes, small holes were drilled in the sidewalls of the display compartment and covered with light baffles. When the 7-1/2-watt bulb in the light housing was on, the illumination in the display compartment (as measured through the window) was found to be about 7 footcandles.

During the experiment, the two apparatus units were situated well apart on tables in a completely darkened experimental room. Two heavy-duty electric fans provided a continuous complex masking sound in the experimental room. Programming of stimulus presentation and recording of responses was accomplished with conventional equipment in an adjoining control room.

D. PROCEDURE

The subjects were randomly divided into eight groups, each group consisting of four males and four females. Subjects were tested two at a time during a single one-hour session. The hour-long session was divided into three successive intervals of 20 minutes each. During the first and third 20-minute intervals, which will be referred to as the operant-level and extinction periods respectively, the display compartment remained dark at all times. During the second 20-minute interval, arbitrarily called the conditioning period, bar presses by the subjects had one of several consequences, depending on group assignment. Table 1 indicates the designations or names of the eight groups;

shows, for each group, what stimulus was present in the display compartment during the entire one-hour length of the test session; and summarizes how the members of each group were treated during the conditioning period.

Subjects in the Bar-Mouse and Yoked-Mouse groups, tested with stimulus mice present in their display compartments at all times, were paired for simultaneous testing in the two apparatus units. During the conditioning period, every bar press by a member of the Bar-Mouse Group resulted in illumination of its own display compartment for as long as the bar was depressed; it also resulted in illumination of the display compartment of the paired control subject in the Yoked-Mouse Group, for the same duration. Bar presses by the Yoked-Mouse subject were recorded, but had no effect of producing or terminating illumination of its display compartment or that of the Bar-Mouse subject. The data yielded by the subjects in the Bar-Mouse Group were expected to indicate the degree to which bar-contingent illumination of an active stimulus mouse functioned to reinforce bar pressing. The data of the subjects in the Yoked-Mouse Group were expected to indicate the possible degree to which nonresponse-contingent, intermittent illumination of the display compartment containing an active stimulus mouse attracted the

TABLE 1
GROUPS OF SUBJECTS, STIMULI IN DISPLAY COMPARTMENTS, AND TREATMENTS DURING THE CONDITIONING PERIOD

Group	Stimulus	Treatment
1. Bar-Contingent Mouse or Bar-Mouse	Active mouse	Each bar press illuminated display compartment for duration of press.
2. Yoked-Control Mouse or Yoked-Mouse	Active mouse	Bar presses did not produce illumination, but display compartment was illuminated intermittently by presses of paired mouse in Bar-Mouse Group.
3. Bar-Contingent Block or Bar-Block	Black block	Each bar press illuminated display compartment for duration of press.
4. Yoked-Control Block or Yoked-Block	Black block	Bar presses did not produce illumination, but display compartment was illuminated intermittently by presses of paired mouse in Bar-Block Group.
5. Bar-Contingent Light or Bar-Light	None	Each bar press illuminated display compartment for duration of press.
6. Yoked-Control Light or Yoked-Light	None	Bar presses did not produce illumination, but display compartment was illuminated intermittently by presses of paired mouse in Bar-Light Group.
7. No-Stimulus Dark-Control	None	Bar presses did not produce illumination; testing was in complete darkness.
8. Mouse-Stimulus Dark-Control	Active mouse	Bar presses did not produce illumination; testing was in complete darkness.

subjects in this group to the display compartment or affected their activity levels.

Subjects in the Bar-Block and Yoked-Block groups, paired for simultaneous testing in the two units, were tested with mouse-size black blocks present in their display compartments at all times. The blocks, which were made of wood and painted flat black, were 2-1/2″ long, 1″ wide, and 7/8″ high. The blocks were placed in the same standard position in the display compartments at all times; namely, they were set back 1″ from the windows with their long sides forming angles of 50° with the lines of the windows. This position was chosen because it corresponded with a frequent resting posture manifested by stimulus animals in the compartments. The data yielded by the subjects in the Bar-Block Group were expected to indicate the degree to which an inanimate visual stimulus with complexity approximating that of a resting stimulus mouse functioned to reinforce bar pressing, when presented on a response-contingent basis. The subjects in the Yoked-Block Group were expected to provide data that would indicate the degree to which nonresponse-contingent, intermittent illumination of the block and the display compartment attracted these subjects to that compartment or increased their activity.

Subjects in the Bar-Light and Yoked-Light groups, also paired for simultaneous testing, were tested with their display compartments empty at all times. During the conditioning period, the subjects in the Bar-Light Group procured presentations of the uniformly illuminated, white interior of the display compartment on a bar-contingent basis while the paired subjects in the Yoked-Light Group were exposed to similar presentations of the empty compartment on a nonresponse-contingent basis. The data provided by the subjects in the Bar-Light Group were expected to provide an indication of the possible light-reinforcing potential of the empty compartment; the data of the Yoked-Light Group were expected to show whether nonresponse-contingent presentations of the lighted compartment functioned in an attracting or in an activity-increasing way.

The No-Stimulus and Mouse-Stimulus Dark-Control groups were tested in total darkness in all three periods of the one-hour test session. For members of the No-Stimulus Dark-Control Group the display compartment was empty at all times; for subjects in the Mouse-Stimulus Dark-Control Group the display compartment contained an active stimulus mouse at all times. The data of the No-Stimulus Dark-Control Group were expected to provide an unconditioned-responding or operant-level base line against which effects of treatments of the other groups could be evaluated. Comparison of the data yielded by the members of the Mouse-Stimulus Dark-Control Group with the data provided by the No-Stimulus Dark-Control Group was expected to reveal the degree to which, if any, subjects were attracted to the display compartment or were activated to press the bar by other than visual forms of stimulation which conceivably could arise from the presence of an active stimulus mouse in the compartment. The subjects in the two Dark-Control groups were paired for simultaneous testing. The two apparatus units were not yoked.

Testing was done between the hours of 8:00 A.M. and 1:00 P.M. on several days irregularly spaced over a month as available subjects in several litters attained predetermined testing ages. A systematic testing schedule was followed so that two subjects, one male and one female in each group, were tested at each of the four daily testing times. The schedule provided further that over the several test days, four subjects (two males and two females from each group) were tested in each of the two apparatus units.

The stimulus animal, in every instance, was a male mouse which, on a prior test day, had been given a one-hour session under operant-level (dark) conditions in the work compartment of one of the units. Stimulus mice were used once only to insure that the activity patterns manifested by these mice when in the display compartments would have some uniformity.

Both subject mice and stimulus mice were maintained in communal living cages, with constant access to food and water until immediately before use in the experiment. Neither food nor water was available either to the subjects or to the social-stimulus animals in the apparatus units.

After each use, the display and work compartments of the apparatus units were carefully wiped clean with damp paper towels; and the paper under the wire-mesh floors of the work compartments was changed. It should be noted that on the day preceding the first test day a "dry run," involving four pairs of subject mice handled in accord with the procedure of the experiment, was performed. This "dry run" confirmed the proper operation of the stimulus-presentation and recording equipment, provided for diffusion of mouse odors in the new apparatus units, and yielded stimulus mice to be used on the first test day.

E. RESULTS

Statistical analyses show that the Mouse-Stimulus and No-Stimulus Dark-Control groups do not differ significantly either in terms of mean total response time (i.e., the time that the bar remained in the depressed position) or in terms of mean response frequency during the three periods of the test session. Because the presence or the absence of a mouse in the display compartment did not (and does not) influence responding in the Dark-Control groups, the subjects in these two groups were recombined randomly to form two equal-size equal-sex groups for the purposes of the statistical analyses to be described. One of these groups was arbitrarily designated as the Bar-Contingent Dark-Control Group; the other, as the Yoked-Control Dark-Control Group.

The means of the time and the response frequency measures for each of the eight main subgroups during each of the three phases of the experiment are shown in Table 2. Because sex differences were not found to be significant in any of the statistical analyses, the means listed in the table represent combined male and female subgroups. Examination of the means in Table 2 suggests (*a*) that differences among the groups during the initial operant level period were slight, (*b*) that prominent differences among the groups appeared during the conditioning period, and (*c*) that the conditions imposed during the conditioning period were still in evidence to some degree during the extinction period.

TABLE 2
MEAN TOTAL RESPONSE TIMES AND MEAN NUMBERS OF RESPONSES DURING THE THREE SUCCESSIVE PERIODS OF THE TEST SESSION

	Mean total response time (in .01 min.)			Mean number of responses		
Group	Operant level	Conditioning	Extinction	Operant level	Conditioning	Extinction
Bar-Contingent						
Dark-Control	52.9	68.5	59.4	26.0	22.0	22.1
Light	46.0	173.5	82.6	26.5	45.6	25.3
Block	40.9	212.4	124.8	24.4	54.1	37.8
Mouse	53.1	204.8	106.9	26.3	58.9	41.4
Yoked-Control						
Dark-Control	45.8	77.8	63.0	25.0	34.1	23.3
Light	44.4	68.6	48.4	28.5	37.8	18.9
Block	62.1	148.6	84.8	28.6	60.9	28.9
Mouse	78.1	105.9	94.0	27.5	46.3	27.5

The response-frequency and response-time measures summarized in Table 2 were assessed with a series of $2 \times 2 \times 4$ analyses of variance applied separately to the data obtained during each of the three periods. In these analyses, the variables considered were sex, contingency of stimulus presentation (Bar-Contingent *vs.* Yoked-Control), stimulus presented during conditioning (Dark *vs.* Light *vs.* Block *vs.* Mouse), and their various interactions.

The analyses of variance applied to the operant-level data confirm the impression (implied by Table 2) that the means of the groups did not differ greatly during the initial period when all subjects were tested under essentially the same dark, operant-level conditions. For both response-time and response-frequency measures, the between-groups F ratios are less than one.

The analyses of the response-time and response-frequency measures during conditioning yields the following reliable and unreliable effects. First, bar-contingency of stimulus presentation results in greater response time ($F = 8.82$, $df = 1$ and 48, $p < .01$), but does not influence response frequency ($F < 1$). Second, the stimulus presented during conditioning is a significant determiner of both response time ($F = 4.56$, $df = 3$ and 48, $p < .01$) and response frequency ($F = 3.12$, $df = 3$ and 48, $p < .05$). Finally, the interaction between contingency of stimulus presentation and nature of stimulus presented is not statistically significant either in terms of response frequency ($F < 1$) or in terms of response time ($F = 1.49$, $df = 3$ and 48, $p > .10$). The order of influence of the various stimuli is statistically the same for the bar-contingent and yoked-control groups.

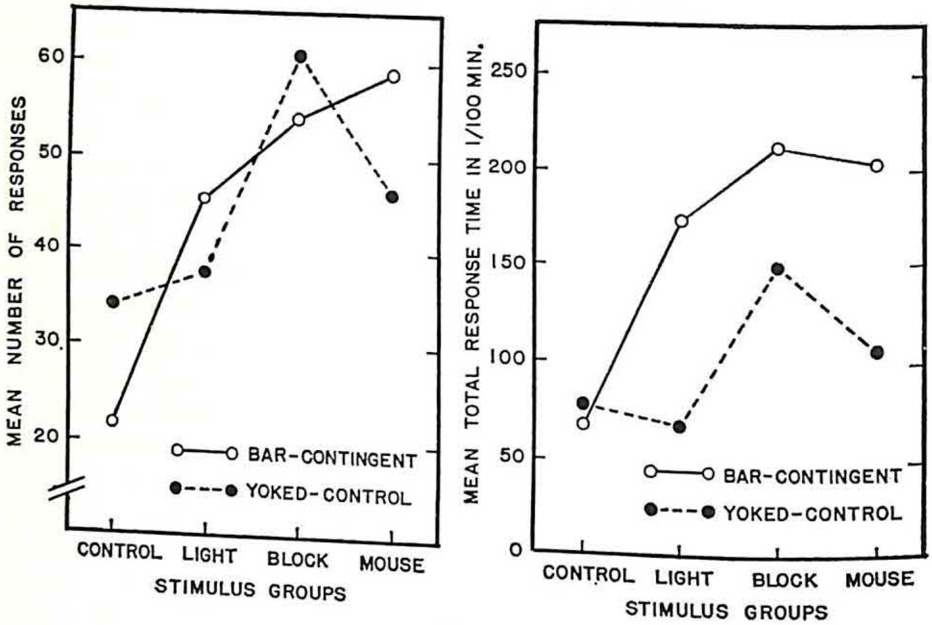

FIGURE 1

Mean Numbers of Responses (Left Panel) and Mean Total Response Times (Right Panel) of the Four Bar-Contingent and Four Yoked-Control Groups During the Conditioning Period. The Groups Have Been Arranged Arbitrarily on the Base Lines in Apparent Order of Increasing Complexity of Visual Stimulus Conditions

To facilitate appraisal of the differences among the eight main groups during the conditioning period, the mean time and mean response-frequency scores of the groups (as listed in Table 2) are presented graphically in Figure 1. The right panel of Figure 1 shows that each of the three Bar-

Contingent Visual Stimulus groups manifested higher mean response times than the Bar-Contingent Dark-Control Group; the left panel shows that these three groups also manifested higher mean response frequencies than their associated Dark-Control Group. Comparisons of the mean response times and frequencies of the four Bar-Contingent groups (on *t* tests) indicates that the difference between the Dark-Control Group and each of the other three groups is reliable at the .05 level or better, except for the response-frequency difference between the Bar-Light and Dark-Control groups. Although the data in Figure 1 show that the Bar-Block and Bar-Mouse groups manifest higher mean response times and frequencies than do the Bar-Light Group, differences among these groups are not acceptably reliable.

Other features of the results that are easily seen in Figure 1 are the relationships (during conditioning) of the mean response times and frequencies of the four Yoked-Control groups to one another and to corresponding mean scores yielded by their respective Bar-Contingent groups. The left panel shows that the Yoked-Control groups do not differ substantially from their respective Bar-Contingent groups in mean numbers of responses emitted during conditioning. It is also noteworthy that the effects of the three visual stimuli on response frequency are roughly the same whether presented on a Yoked-Control or a Bar-Contingent basis. Both of these points were made above in the discussion of the results of the analysis of variance of these data.

With respect to the effects of Yoked-Stimulus presentations on response time, the picture is more complicated, as the right panel of Figure 1 shows. The Yoked-Control groups manifest lower mean response times than do their respective Bar-Contingent groups in all comparisons (except, as would be expected, in the one involving the two Dark-Control groups). Evaluations with *t* tests show that the difference between the mean response times of the Bar-Light and Yoked-Light groups, as well as the difference between the mean response times of the Bar-Mouse and Yoked-Mouse groups, is reliable at the .05 level of confidence at least. However, the difference between the mean response times of the Bar-Block and Yoked-Block groups is not of acceptable reliability ($p > .10$).

Two additional analyses of variance applied to the response time and response frequency scores of the various subgroups during the extinction period do not reveal any significant intergroup differences despite the indication (in Table 2) that the Bar-Block and Bar-Mouse groups achieved higher response-time and response-frequency scores than do the Bar-Light and the Bar-Contingent Dark-Control groups, during the final period.

Changes in means of both the time and the response-frequency scores—

from the operant-level (OL) period to the conditioning (C) period—were assessed with *t* tests. These tests show that, for the Bar-Light, Bar-Block, and Bar-Mouse groups, the increases in the means of the time scores from OL to C are significant at the .01 level or better; for the Bar-Contingent Dark-Control Group the mean increased only slightly and not significantly. For the four Yoked-Control groups for which all C minus OL mean differences are positive, only the change for the Yoked-Block Group is statistically significant ($p < .01$). The C minus OL mean response frequencies, similarly assessed with correlated-variables *t* tests, are significant at the .01 level of confidence or better for the Bar-Light, Bar-Block, and Bar-Mouse groups, while the mean of the Bar-Contingent Dark-Control Group declined slightly and not significantly. Among the four Yoked-Control groups for which the mean response frequency scores increased from OL to C, only the increase for the Yoked-Block Group is found to be reliable ($p < .05$).

Changes in the means of the response measures from OL to extinction were also assessed with *t* tests to determine if, by this method of appraisal, any effects of the conditioning treatments carried over to the final period. The only significant OL-to-extinction change found in the time scores is the increase for the Bar-Block Group ($p < .05$). The OL-to-extinction increase in time for the Bar-Mouse Group, though sizable, is not statistically significant ($p < .10$). The analyses of the OL-to-extinction changes in the response-frequency scores reveals only one change of acceptable reliability: namely, the decrease in the instance of the Yoked-Light Group ($p < .02$).

F. Discussion

The main purpose of the present study was to determine whether the visual aspect alone of the pattern of stimulation provided by an active mouse can reinforce the bar-pressing activity of another mouse. The fact that the No-Stimulus and Mouse-Stimulus Dark-Control groups as initially formed did not differ significantly either in terms of response frequency or in terms of total time spent in bar depression at any point in the test session established the point that the apparatus developed for this experiment effectively restricted social stimulation to the visual dimension.

Although the results show that highly reliable increases in both the response time and response-frequency scores of the Bar-Mouse Group occur when the sight of a stimulus mouse is made response-contingent, when the control data are taken into consideration it cannot be stated with certainty that the heightened responding of that group is necessarily a consequence either of the unique social nature of the stimulation provided by the stimulus mouse or of response contingency of such stimulation. The control data indicate that response-contingent presentation of the nonsocial visual stimuli used (namely, the empty display compartment and the black, mouse-size block) increases response scores to almost the same levels to which these scores are increased when the sight of the stimulus-mouse is made response contingent. The control data also show that yoked-intermittent presentation of the stimulus-mouse, as well as of the other two visual stimuli, results in increases in response frequencies (but not in response times) that, statistically, are equivalent to those that result when these same stimuli are presented on a response-contingent basis.

Further consideration of the results leads to the conclusion that visual presentation of the stimulus mouse is no more reinforcing than presentation of the illuminated empty compartment or of the mouse-size block. Although the Bar-Mouse Group exceeds the Bar-Block and Bar-Light groups in terms of response frequency, failure attended all attempts to establish statistically significant differences among these groups, during conditioning and extinction. Further, when the indications of the (apparently) more sensitive response-time measure are considered, the implication is that the active stimulus mouse is less—not more—reinforcing than the mouse-size block. During conditioning, the Bar-Block Group time score is larger than that of the Bar-Mouse Group, and the Bar-Block Group is the one group that shows a significant degree of carry-over of the effects of the conditioning treatment to the extinction period. Because the differences between the means of the time scores of these two groups are not significant, in either the conditioning or the extinction period, detailed speculation concerning the "reason" that the block is more reinforcing than the mouse is not warranted. It is worth pointing out however, that, in a prior study, Antonitis and Kish (3) showed that inactive stimulus mice reinforce more effectively than do active social stimuli aggregative behavior in other mice. This similarity, between the results of the present study and the prior one, suggests that the block, which was intended originally to serve as a control for the sensory reinforcing effects of nonsocial visual stimulation (of about the same complexity as the stimulation mediated by an inactive mouse), serves as a generalized social stimulus; i.e., it is reacted to as if it were an inactive mouse. Whether or not this be true, the present results indicate that, for a black mouse of the strain used, the sight of a black block is not less reinforcing than the sight of a black stimulus mouse. In this connection, it would be interesting to know how some of the white rats used by Angermeier (1) would have reacted had they been provided with an opportunity to press a bar to see a white rat-size block. But additional control groups, similar to the ones used in the present study, would still be needed in any replication of Angermeier's work to establish whether or not the simple sight of a rat reinforces the bar pressing of another rat. Similarly, the only other available study of a form of social reinforcement of bar pressing in rats reported recently is that by Rice and Gainer (7). Even though Rice and Gainer used white-block control groups, their study needs to be replicated with additional controls to establish definitely whether "altruism" is or is not manifested by rats. It should be noted, however, that Rice and Gainer recognized the need for a better-controlled experimental design to substantiate the indications of their initial exploratory study.

How the factor of contingency of stimulus presentation functioned in the present study to determine bar pressing for visual reinforcers is a matter of interest that warrants some discussion. When the response-time data are considered, there is no doubt that the response-contingent presentation of the three visual stimuli serves to strengthen this aspect of bar pressing markedly because the groups of subjects that procure these stimuli on a response-contingent basis significantly exceeds the response times of their respective Yoked-Control and Dark-Control groups. But when the response-frequency data are examined, these data indicate that the Bar-Contingent subjects do not respond more frequently than do the Yoked-Control subjects. The time measure indicates that the factor of response contingency of stimulus presentation is an important determiner of bar pressing while the frequency measure indicates that it is not. These conflicting indications regarding the way in which response contingency functioned in the present study are resolvable on the assumption that conditioning is manifested as an increased tendency of the subjects to hold the bar down rather than as a tendency to press and release the bar more frequently. Consideration of the test procedure that provided that the interior of the display compartment would be visible for only so long as the bar was depressed lends validity to this assumption. If the assumption is accepted, then the heightened response frequencies of the Yoked-Control subjects during the conditioning period may be accounted for as indicating that the novel, intermittently illuminated display compartment serves to attract these subjects to its neighborhood where their investigatory movements result in fortuitous bar presses. An alternative explanation of the heightened response frequencies of the yoked-control subjects is that, during conditioning, such increased responding reflects true (but "surreptitious") conditioning of bar pressing, by occasional adventitious illuminations of the compartment that happen to coincide with bar presses. Observations of the recording equipment while the experiment was being conducted indicated that control illuminations of the display compartment that coincided with presses of the Yoked-Control subjects were not infrequent, especially at the start of the conditioning period. Two aspects of the data, however, suggest that this latter explanation is not as tenable as the heightened activity hypothesis. First, the Yoked-Control subjects do not show conditioning in terms of the presumably more valid time measure; and, second, as may be determined by reference to the data in Table 2, the responses of the Yoked-Control subjects are of shorter average durations than those of the Bar-Contingent subjects. On a priori grounds it appears that fortuitous bar presses would be of short duration.

Why the results of the present study do not indicate more conclusively that the sight of a mouse or of a (presumably) "generalized" mouse in the form of a black block is more reinforcing than the sight of an empty compartment can only be conjectured. One guess is that the sensory reinforcing effect of the illuminated empty compartment is so great that the addition of either of the other stimuli does not add a significant measure of reinforcing potential. If this guess be correct, then the bar-press test situation has less to recommend it for purposes of analyzing the reinforcing effects of social stimulation on the behavior of rodents than does the field-platform social-test situation described in earlier publications (3, 4).

G. SUMMARY

The question whether the visual stimulation alone provided by an active mouse can suffice to reinforce the bar pressing of another mouse was studied with eight groups of eight subjects each in order to obtain needed controls. Behavioral measures for a group of subjects whose bar presses illuminated the interior of a glass-faced display compartment were compared with those yielded by other groups of subjects whose bar presses revealed either an empty compartment or a mouse-size block within the compartment. Other groups of subjects tested on a Yoked-Control basis yielded data concerning the effects of nonresponse-contingent presentation of these visual stimuli. Two additional Dark-Control groups were used to assess bar pressing in complete darkness. The subjects in one of the Dark-Control groups were tested with a mouse present in the display compartment; the subjects in the other group, with the compartment empty. Test sessions were one-hour long and were divided into successive operant-level, conditioning, and extinction periods.

The absence of differences between the two Dark-Control groups confirmed the assumption that the apparatus limited social stimulation to the visual aspect. Although the Bar-Contingent Mouse-Stimulus Group exceeded the Dark-Control groups in both frequency and temporal duration of bar pressing,

the fact that response-contingent presentations of both the empty compartment and of the block resulted in equivalent elevations of response measures led to the conclusion that the sight of the stimulus mouse is no more reinforcing than the sight of an empty compartment with or without the block. It was conjectured that the sensory reinforcing effect of compartment illumination is so great that addition of social stimulation does not add measurable reinforcing potential.

The results also show that during conditioning the Bar-Contingent subjects exceed their respective Yoked-Stimulus controls in terms of response times, but not in terms of response frequencies. It is suggested that the heightened response frequencies of the Yoked-Control subjects reflects heightened activity rather than surreptitious conditioning.

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YOUNG THINKERS AND MEMORABLE CREATIVE ACHIEVEMENTS* [1]

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A. INTRODUCTION

"On the day of Cromwell's death, when Newton was sixteen, a great storm raged all over England. He used to say, in his old age, that on that day he made his first purely scientific experiment. To ascertain the force of the wind, he first jumped with the wind and then against it; and, by comparing these distances with the extent of his own jump on a calm day, he was enabled to compute the force of the storm. When the wind blew thereafter, he used to say it was so many feet strong." (33, p. 407)

Although interesting, the foregoing youthful experiment of Newton is not included in the list of memorable creative achievements that follows because it yielded nothing of permanent value to the field of physics. The significance of the achievements to be listed lies in the fact that each of them has been of lasting value and that each was the work of a fledgling not over 21 years old at the time of the indicated accomplishment.

This is the third such list that I have assembled. [See (23, pp. 180-183; 200-217)]. Collectively, they include a total of more than 200 significant attainments. And these comprise only a fraction of the number that doubtless could be assembled if a more thorough search of the literature were made, or if the high standard of excellence required for inclusion were lowered. Contributions made by individuals more than 21 years old have been excluded because if those made by persons only one or two years beyond age 21 had been included each of the three accounts would have had to be book length.

The technical terms need not be understood in order to follow the gist of what follows. Some of the quotations are difficult to understand because they were obtained from serious, hard-to-read sources, and the reader can omit them without missing the main point of the discussion. The quotations serve a serious purpose, however, and some who may want to skip the more difficult ones at first perhaps will be motivated to read them after perusal of the more interesting ones. Because I have no special competence in the

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several fields of endeavor that will now be mentioned, I shall let the historians whose books I have studied, speak for themselves.

B. Achievements

Aristotle (384 B.C.-322 B.C.) *Physics*

In the year 365 B.C. Aristotle [age 19] investigated the acceleration of free-falling bodies (1, p. 311).

Bacon, Francis (1561-1626) *Scientific Method*

As a setting for this paper, I would like to go back almost 400 years to a rebellion started by a 14-year-old school-boy. The boy was Francis Bacon; the year 1575; the setting, Cambridge University. The rebellion turned out to be one of the most important revolutions in the whole history of thought, for the school-boy Francis Bacon became the first prophet of the scientific age, and to do that he had to overthrow the whole system of scientific thought of the philosophers and learned men of his day. . . .

"Contrasting the social utility of inventions with the sterility of the theory-spinning of philosophers, Bacon started his rebellion. Clearly it was no minor tyranny he sought to overthrow. On the contrary, he set out to be a giant-killer, to overthrow the whole system of scientific thought of the philosophers and to remake the world in order that all men might live fuller, happier, and healthier lives. Prevailing thought before Bacon's time did not conceive of a drastic improvement in the conditions of human life. Bacon did conceive of such an improvement. He foresaw, and was perhaps the first to foresee, that this goal could be achieved by a great scientific revolution. To the grand design of that revolution he devoted his life (44, p. 179).

Baeyer, Johann Friedrich Adolf von (1835-1917) *Chemistry*

Johann Friedrich Adolf von Baeyer was born in Berlin in 1835. . . . When only twelve years old, he discovered a new double carbonate of copper and sodium, and his experiments with indigo the next year started his interest in this dyestuff (31, p. 303).

Bailey, Harry (1898-1946) *Pathology*

Bailey [age 21] wrote *Serological Reactions in a Case of Rhinoscleroma,* 1919 (14, p. 334).

Bartholin, Caspar (1655-1738) *Anatomy*

Caspar Bartholin, Danish anatomist (1655-1738), discovered the major vestibular glands, one on each side of the vaginal orifice. Reported in 1675 [age 20]. Known as *Bartholin's glands* (35, p. 534).

Baudelocque, Jean Louis (1756-1810) *Obstetrics*

His *Principles des accouchments,* published in Paris in 1775 [age 19] went through five editions (28, vol. 2, p. 638).

Beilstein, Friedrich Konrad (1838-1906) *Physics*

Sir W. Thomson (1824-1907) measured the density of layers by using floating glass pearls of different specific gravities (*Encycl. Brit.* 11, p. 586, 1856) In 1856 [age 18] Beilstein with his method could quickly perform new experiments on the diffusion of different solutions wherein he contrived to have the solution in a short U-tube, closed at the top, and placed in the top layer of the solution in a water container. The apparatus is still (1905) much used for instructional purposes (*Lieb. Ann.* **99**, p. 92f).

Bernoulli, Christoph (1782-1863) *Luminescence*

"The first essay, devoted entirely to bioluminescence, was by Christoph Bernoulli (born 1782) entitled, *Ueber das Leuchten des Meeres mit besonderer Hinsicht auf das Leuchten tierischer Körper,* a pamphlet of 182 pages published at Göttingen in 1803 [age 21] . . . According to Heinrich this was presumably an answer to a prize question and was quite superior to other papers of the time. It is divided into six parts, with Parts I to V devoted to sea light, leaving Part VI to take up the origin of light in animal bodies (16, p. 199f).

Blanchet, Alexander-Louis-Paul (1829-1867) *Ototogy*

Alexander-Louis-Paul Blanchet reported a case 1849 [age 20], of hearing in which no auditory nerve existed. It is to be assumed that what he was dealing with was the perception of vibratile sensation by somatic nerves, rather than hearing as such (29, p. 1079).

Bolyai, Janos (1802-1860) *Non-Euclidean Geometry*

In 1823, Bolyai's son Janos (1802-1860), then barely twenty-one years old, wrote to his father of a new discovery saying, 'I have created a new universe from nothing.' This enthusiasm was well founded, for he had developed a new system of geometry on the acute-angle hypothesis. . . . Amazing as this was in contrast to Euclidean geometry, it was equally logical (34, p. 279). This was the first systematic non-Euclidean geometry.

Bowen, George T. (1803-1828) *Chemistry*

George T. Bowen (1803-1828), a student of the elder Silliman, as early as 1822 [age 19] carried on investigations upon 'The Electro-magnetic effects of Hare's Calorimotor,' and wrote 'On a Mode of Preserving in a Permanent Form the Coloring Matter of the Purple Cabbage as a Test for Acids and Alkalies,' as well as described the minerals scheelite, silicate of copper, nephrite, and pyroxene-sahlite (39, p. 222).

Brahe, Tycho (1546-1570) *Astronomy*

His interest in astronomy was still further aroused when, incidentally, in the year 1563 [age 19], at the time of the nearest apparent approach of Jupiter and the sun to each other, he was able with his simple apparatus to demonstrate that, not only the Alfonsine tables but also the so-called Tabulae Prutenicae, calculated on the Copernican principles were incorrect (22, vol. 1, p. 63f).

Brunner, Jean Conrad (1653-1727) *Anatomy*

Jean Conrad Brunner (1653-1727) discovered the glands still known as Brunner's glands in the submucosa of the duodenum at the age of nineteen, though he did not publish his work on them until fifteen years later when he became Professor of Medicine at Heidelberg (12, p. 124).

Buerger, Heinrich (1799-1861) *Pathology*

Heinrich Buerger (1799-1861) studied at Halle and Berlin. He received his medical degree, 1819. The next year [age 21] he wrote *Die Kraetze in patholog. und Therapeut. Hinsicht.* (*Scabs in pathological and Therapeutical Perspective*) (14, p. 120).

Capablanca, José Raoul (1888-1942) *Chess Championships*

Capablanca has been compared to Morphy, and that comparison has its justification when one considers the similarity in style of their play and the unusually early age at which they both commenced to develop. At the age of thirteen we find Morphy winning games from such a seasoned player as Löwenthal. At twelve Capablanca beat the champion of Cuba in a set match. At the age of twenty Morphy overcame Anderssen by 7-2 and 2 draws. At the same age Morphy won against all the masters who stood up to him, whilst Staunton denied him the opportunity of a match. In the same way at San Sebastian, the strongest tournament ever held, Capablanca gained a well-deserved victory, and Lasker also, when challenged in 1911, evaded meeting him in a match.

(5, p. vi). For further comment with reference to Paul Morphy's chess prowess see (23, p. 210).

Chittenden, Russell Henry (1856-1943) *Chemistry*

In 1875 [age 19] he discovered glycogen and glycine in 'scallops' (3, p. 159).

Clemow, Frank Gerard (1883-1939) *Pathology*

In 1903 [age 20], he published a book entitled *The Geography of Disease,* Cambridge. *Univ. Press* (32, p. 108).

Crookes, Sir William (1832-1919) *Chemistry*

His first paper entitled 'On the Selenocyanides' was published when he was nineteen years of age (43, p. 635).

Curie, Pierre (1859-1936) *Ultrasound*

The idea of ultrasound is not new. In 1880 Pierre Curie [age 21] codiscoverer of radium, and his brother Jacques found that certain crystals subjected to mechanical pressure give off surface electrical charges proportional to this stress (15, p. 34).

Deiters, Otto Friedrich Carl (1834-1863) *Anatomy*

O.F.C. Deiters (1834-1863) demonstrated [at age 21] the connection of the nerve cell with the axis cylinder (6, p. 772).

Despretz, César Mansuète (1792-1863) *Physics*

Aside from Watt's experiments, one can find in Robison's work another whole series of experiments, including those of Southern and Crighton, yielding the same results. A thorough discussion of Watt's law ensued. Of greater significance in this connection are the following works: Rumford (*Nich. Journ.* 1812) finds the latent heat of vaporization of water is 576 calories per gram; Ure (*Phil. Trans.* 1818) found it 537.22 calories per gram; Despretz (*Ann. de Chim. et Phys.* 24, 1813) [age 21] placed it between 513 and 540 calories per gram (19, p. 199).

Dobie, William Murray (1828-1915) *Anatomy*

William M. Dobie, English anatomist, 1818-1915, described a dark line (actually a membrane) in the center of a light band of a striated muscle fiber. It serves to limit the sarcomere. Reported in 1849 [age 21]. Known as *Dobie's line* (35, p. 464).

Dumas, Jean Andre Baptiste (1800-1884) *Chemistry*

One day in 1819, when nineteen-year-old J. B. Dumas had charge of the laboratory at the Le Royer pharmacy in Geneva, Dr. Coindet asked him to test some calcined sponge for iodine. When the boy obtained clear proof of its presence, Dr. Coindet asked him to suggest different forms in which iodine could be conveniently administered. Even before any iodide was commercially available, Dumas proposed the tincture of iodine, potassium iodide, and a solution of iodide in potassium iodide. The memoirs on this subject signed 'A Le Royer, pharmacist, and J. B. Dumas, his pupil' were published in 1819 and 1820 in Meisner's journal in Berne (42, p. 447f).

Dumas, Jean Andre Baptiste (1800-1884) *Blood Transfusion*

Transfusion of whole blood or plasma or blood substitutes (known since the seventeenth century) has been so greatly advanced in recent years that it constitutes one of the important therapeutic achievements of the twentieth cenury. The early attempts, in spite of frequent untoward results, had not been forgotten, though it was not until the nineteenth century that study of the subject was resumed (Prevost's and Dumas's use of defibrinated blood, 1821) [Dumas age 21] (6, p. 1060).

In 1821 in collaboration with Jean Andre Baptiste Dumas (1800-1884) Jean Louis Prevost published in the *Ann. de Chim.* (Paris), an article entitled "Examen due sang et de son action dans les divers phenomenes de la vie." This was the first attempt to prevent coagulation during transfusion, and the first successful use of defibrinated blood for animal transfusion (32, p. 121).

Euler, Leónhard (1707-1783) *Physics*

Euler worked on the problem of the synchronism of vibrations from 1724 [age 17] (*Mem. Peters.* 9, p. 20) until 1773; he then attempted to define curves as tautochronen,[2] and he next tried to find the tautochronen in a resisting fluid (19, p. 27).

Frank, Johann Peter (1745-1821) *Public health control*

Johann Peter Frank, German physician, 1745-1821, advocated public control of health problems as early as 1766 [age 21] (35, p. 392).

Fraser, James Earle (1876-1921) *Sculpture*

The sculptor who created America's most popular statue,—'The End of the Trail'—an Indian slumping on his tired horse—also designed the buffalo nickel. . . . At 17 he had completed the statue of 'The End of the Trail' and he took it with him when he went to Paris in 1895. His success there was immediate (27, pp. 117f).

Galen (c. A.D. 130-c. 200) *Medicine*

He studied in Smyrna, and by the time he was 21, had become a well trained doctor. He also had written a textbook on the uterus for midwives, a work on ophthalmology and three books on pulmonary disease and its treatment. But, like a true philosopher, he concluded that he knew nothing (2, p. 42f).

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[2] A tautochronen is a mathematically defined curve which describes the motion of bodies under the influence of gravity.

Genga, Bernardino (1655-1734) *Anatomy*

In 1672 [age 17] he published the first book devoted entirely to surgical anatomy (32, p. 33).

Glauber, Johann Rudolf (1604-1670) *Chemistry*

At the age of twenty-one he discovered the medicinal value of sodium sulfate, which has since been known as Glauber's salt (42, p. 183).

Golgi, Camillo (1844-1926) *Histology*

The distinguished Italian neurohistologist, Camillo Golgi (1844-26), in his graduation thesis at Pavia (1865) [age 21] wrote a critical review on the need for a classification of mental diseases according to (a) microscopic structural changes in the brain, and (b) causal factors (12, p. 211).

Gray, Henry (1827-1861) *Anatomy*

While a student he prepared an essay of 341 pages which won the Triennial Prize of the Royal College of Surgeons in 1848 [age 21], the year of his qualifying examinations for the M.R.C.S. His subject was *The Origin, Connection and Distribution of the Nerves of the Human Eye and its Appendages, illustrated by Comparative Dissections of the Eye of other Vertebrate Animals. . . .*

"This student dissertation is probably without parallel as a comprehensive survey of the phylogeny of the nervous structures associated with vision and eye movements. . . . From his own dissections and from preparations which he studied at the Museum of the Royal College of Surgeons, Gray collected the material for this amazing work (12, p. 22).

Greenwood, Isaac (1702-1745) *Medicine*

The doctrine of inoculation spread rapidly in the American colonies, as can be seen in the papers by B. Colman, Isaac Greenwood, Cotton Mather,, William Cooper, and William Douglass, all appearing in 1721 or 1722 [Greenwood age 19 or 20]. (6, p. 641).

Grubbe, Emil Herman (1875-1960) *Medicine*

Recognition of the effects of X-ray on the tissues led to its use in treatment, first of the dermatoses. . . . E. H. Grubbe is said to have applied them to cancer of the breast and to lupus vulgaris in January 1896 [age 21] and himself to have acquired an X-ray dermatitis; but he made no publication until 1933 (6, p. 1071).

Guyot, Édme Gillis (1706-1786) *Medicine*

Edmé Gillis Guyot, French feldsher and postmaster, 1706-1786, is credited with being the first to catheterize the auditory tube, by way of the mouth. Recorded in 1724 [age 18] (35, p. 161).

In 1724 [age 18] he published an article entitled "Instrument pour seringer la trompe d'Eustache par la bouche." in the *Hist. Acad. roy. d. Sci.* (30, p. 190).

Gwynne, James Stuart (1831-1915) *Hydraulic machinery*

Centrifugal pumps began to appear in the mid-nineteenth century, and were shown at the Great Exhibition of 1851 [age 20] by James Stuart Gwynne (1831-1915) (38, vol. 5, p. 524).

Haller, Albrecht von (1708-1777) *Anatomy*

Albrecht von Haller, Swiss physiologist and anatomist, (1708-1777), identified the lingual vein as a blood vessel in 1727 [age 19]. Previously it was considered by many as a salivary duct (35, p. 271).

Harrison, Ross Granville (1870-1959) *Medicine*

External causes of cancer were demonstrated before the end of the nineteenth century, among others by Richard von Volkmann (tar and paraffin cancer, 1875); Hürting and Hesse (miner's cancer of the lung, 1879); R. H. Harrison (bilharzia cancer of the bladder, 1889 [age 19]); L. Rehn (aniline cancer, 1895) (6, p. 804).

Hartsoeker, Nicolaus (1656-1725) *Practical Invention*

At the beginning of the *"Cours de Physique,"* 1730, written by Hartsoeker (1656-1725), who was one of Leeuwenhoek's contemporaries, there is an "Eloge" of Hartsoeker written by Fontenelle, in which it is stated that one evening when he was eighteen years old Hartsoeker was playing with a thread of glass, without intention, when he put the end in the flame of a candle, and he noticed that as it melted the end formed itself into a spherical head. As he knew already that a ball of glass enlarged objects placed in its focus, and when he had visited Leeuwenhoek with his father he had seen Leeuwenhoek's microscopes and noted their construction, he took the ball which he had formed, detached it from the rest of the rod and made a microscope with it. He tried this first upon hair. He was delighted to find it good and to have the power of making a microscope at so little cost (7, p. 42).

Heaviside, Oliver (1850-1925) *Geodesy*

From 1865 to 1872 [ages 15 to 22] a very thorough series of pendulum observations was made in India by Basevi and Heaviside (1850-1865) 38, Vol. 5, 444).

Helmholtz, Hermann von (1821-1894) *Anatomy*

His inaugural dissertation dealt with the origin of nerve-fibers from cells in the ganglia of leeches and crabs, which he had observed with a rudimentary compound microscope (1842) [age 21] (10, p. 532).

"Receiving his medical degree in 1842 [age 21], he described in his doctor's thesis, an important discovery—the anatomical connection between nerve cells and the nerves themselves (28, Vol. 2, p. 804).

Herissant, Louis Antoine Prosper (1745-1769) *Practical Invention*

Many of the early investigations had as their object the discovery of a satisfactory solvent for the solid rubber which, being tough and resilient, did not lend itself to manipulation by any of the processes of manufacture then available. In 1763 the French chemists L. A. P. Herissant (1745-1769) [age 18] and F. J. Macquer proposed the use of rectified turpentine, and in 1786 the latter also found that purified ether was a suitable solvent for rubber (38, Vol. 5, p. 755).

Hill, John (1716-1775) *History of Drugs*

John Hill (1716-1775) included the glowworm (without a figure) under the name 'Cantharis' in his *History of Animals* (London, 1752), describing the male as a small black beetle and the female as the glowworm with no wings, but 'the last three joints of the body are of a yellowish colour on the under surface and these appear ignited or flaming in the dark.' The glowworm is not mentioned as a remedy in Hill's *Compleat History of Drugs* (1737 [age 21] or in the *History of Materia Medica* (1751) (16, p. 545f).

Hippel, Eugen von (1867-1939) *Keratoplasty*

Corneal transplantation (Keratoplasty) has been often attempted: first successfully practised by von Hippel in 1888 [age 21] and by F. Salzer in 1900, then by S. Calderaro in 1908 (6, p. 1024).

Hoffmann, Moritz (1622-1698) *Anatomy*

Moritz Hoffman, German anatomist, 1622-1698, is believed to have discovered the excretory duct of the pancreas in fowl, in 1642 [age 20]. It is also believed that this led to the discovery of the duct in man by Wirsung in the same year (35, p. 346).

Hooke, Robert (1635-1703) *Technology*

Developments between 1850 and 1900 were to lead to the establishment of the fixed-wing aeroplane as the answer to man's long search for an effective aircraft. However, as has been shown, the early pioneers were slow to appreciate the possibilities of fixed-wing flight, They were almost invariably attracted to other more complicated solutions. A very few, such as Hooke (1655) [age 20], de Gusmão (1709), and Ariès (1784), seem to have had ideas along fixed-wing lines. . . . (38, Vol. 3, p. 405).

Hopkins, Sir Frederick Gowland (1861-1947) *Entomology*

Sir Frederick Gowland Hopkins was the "father" of biochemistry in Britain, one of the world's greatest scientists, and was awarded the Nobel Prize for his pioneer work on vitamins. . . . At the age of seventeen he wrote his first "scientific paper," a letter to the *Entomologist.* It was on the bombardier beetle. He had noticed that this insect, when disturbed, ejected a violent vapor into the air. He put specimens in a test tube and encouraged them to shoot. The vapor condensed on the side of the tube, and he collected the material. "I think," he wrote later, "that from that time my fate was sealed. Though the designation was not yet invented, I became there and then a biochemist at heart." He remained fascinated by insects, particularly butterflies. . . . And he kept on reverting to butterfly wings until at the age of eighty, at the end of a great career in which he had become the President of The Royal Society, President of the British Association, Nobel-Prize winner and a member of the rare Order of Merit, he delivered his last paper on butterfly wings (4, p. 55f).

Howell, William Henry (1860-1945) *Physiology*

William Henry Howell (1860-1945), of Baltimore, Maryland, has investigated such problems as the accelerating effect of increased venous pressure on the heart (1881) [age 21]. . . . (10, p. 559).

Humboldt, Alexander (Friedrich Heinrich Alexander) Baron von (1769-1859) *Geology*

Friedrich Heinrich Alexander, Baron von Humboldt (1769-1859) was educated for a political career in Germany. In 1789 [age 20] he wrote a treatise on the geology of the Rhine Valley (31, p. 130).

Huntington, George (1851-1916) *Pathology*

In 1872 [age 21] he gave the classical description of the chronic degenerative hereditary type of chorea that led to the eponym, "Huntington's chorea" (32, p. 257).

This man, George Huntington, was the first to present a clear description of that hereditary affection of adult or middle life which is now known as Huntington's chorea [1872, age 21] (29, p. 592).

George Huntington, American physician, 1851-1916, gave a classic description of chronic progressive hereditary chorea, marked by irregular movements, speech disturbances, and a progressive dementia, in 1872 [age 21]. Known as Huntington's chorea (35, p. 95).

Huxley, Thomas Henry (1825-1895) *Anatomy*

Thomas Henry Huxley, 1825-1895, described a layer of the inner root sheath of a hair follicle, situated between the inner sheath cuticle and Henle's layer. Recorded in 1845 [age 20]. Known as *Huxley's layer* (35, p. 199).

Johnson, Samuel Wilhelm (1830-1909) *Chemistry*

The most potent influence in early American agricultural chemistry was Samuel W. Johnson (1830-1909), the third President of the American Chemical Society, whose youthful essay in 1847 [age 17] upon "fixing Ammonia" gave promise of the man (3, p. 179).

Kratzenstein, Christian Gottlieb (1723-1795) *Electric therapy*

Nollet had already demonstrated the lethal power of a strong electric discharge on small animals. Aside from this very little was known about the physiological effects of electricity. In 1744 [age 21], the physician Kratzenstein (1723-1795) allegedly at school cured a paralyzed finger (20, Vol. 2, p. 42).

Lavoisier, Antoine Laurent (1743-1794) *Practical Invention*

In 1764, his twenty-first year, he was awarded a gold medal offered by the French government for the best method of lighting streets (29, p. 138).

Loewenhardt, Sigismund Eduard (1796-1875) *Pathology*

In 1817 [age 21] he gave the first important account of tabes dorsalis (32, p. 261).

Sigismund Eduard Loewenhardt, German physician (1796-1875), is credited with giving the first recorded description of tabes dorsalis. Published in 1817 [age 21] (35, p. 479).

Levinstein, Ivan (1845-1916) *Technology*

Perkin was not the only young man to perceive the commercial possibility of synthetic dyes, and in 1864 [age 19] Ivan Levinstein (1845-1916) started the manufacture of magenta, violets, Bismarck brown, and other dyestuffs at Blackley, Manchester (38, Vol. 5, p. 274).

Litzmann, Carl Conrad Theodor (1832-1890) *Anatomy*

Carl Theodor Litzmann . . . described oblique, ovoid, scoliotic, and kyphoscoliotic types as well as the coxalgic pelvis [1853, age 21] (29, p. 978).

Lyell, Sir Charles (1797-1875) *Theory of organic evolution*

At the age of twenty he observed on the coast of East Anglia the action of the sea in the formation of new land as well as in the wearing down of the cliffs; and in the following years he found abundant evidence in his native Forfarshire, in the action of rain and rivers and the formation of limestone, that all observable changes in the earth's crust were not owing to the Nachian deluge (24, p. 298).

Macgill, William D. (1802-1833) *Surgery*

In 1823 [age 21] Macgill successfully ligated in continuity both primitive carotid arteries in the same subject within a month. He was the first American to do so (32, p. 171).

Mallet, John William (1832-1912) *Chemistry*

In 1849 [age 17] he published "A Chemical Examination of Killinite" (39, p. 287).

Marshall, John (1818-1891) *Pathology*

In 1835 [age 17] he published "Practical observations on Diseasees of the Heart, Lungs, Stomach, Liver, etc., Occasioned by Spinal Irritation: and on the Nervous System in General as a Source of Organic Disease" (29, p. 574).

Marten, Benjamin (1700-1782) *Bacteriology*

Benjamin Marten, English physician, 1700-1782, proposed a theory of tuberculosis, especially pulmonary tuberculosis, based on the assumption that the causative agent is a microorganism. Published in 1720 [age 20], 162 years before Koch's discovery of the tubercle bacillus in 1882 (35, p. 511).

In 1720 [age 20] he published a book in London entitled "A new theory of consumption, more especially of a phthisis, or consumption of the lungs." He considered a parasitic micro-organism as the cause of tuberculosis, thus forecasting the existence of the tubercle bacillus 162 years before its actual discovery (32, p. 188).

Mease, James (1771-1846) *Pathology*

Mease had previously stated that the poison of rabies depressed the patient. Mease rejected the current belief that the disease could arise spontaneously in man or dogs, 1792 [age 21], and insisted it is only transmitted by a bite and that a wound in the skin was necessary. Mease did not think the stage which the disease had attained in the biting animal made any difference or that the part of the body bitten was significant. Rush subsequently inveigled Nathaniel Chapman to support his opinion in opposition to Mease. Chapman's "An essay on the Canine State of Fever," is merely a proof of its author's willingness to be cast into the role of a Sancho Panza (29, p. 413f).

Merrem, Daniel Carl Theodor (1790-1859) *Surgery*

In 1810 [age 20] he published "Animadversiones quaedam chirurgicae experimentis in animalibus factis illustratae." Giessae, *Tasche et Mueller.* He described here the first experimental excision of the pylorus (32, p. 193).

Monro, Alexander, secundus (1733-1817) *Anatomy*

The Foramen of Monro, has become familiar to all medical students. With reference to its discovery, Monro wrote as follows: "So far back as 1753 [age 20], soon after I began the study of Anatomy, I discovered that the Lateral Ventricles of the human brain communicated with each other, *and,* at the same place with the Middle or Third Ventricle of the Brain. And, as a passage from the Third Ventricle to the Fourth is universally known, it followed, that what are called the Four Ventricles of the Brain, are in reality different parts of one cavity (12, p. 190).

Alexander Monro, *secundus,* Scottish anatomist (1733-1817), described the interventricular foramen of the human brain, the opening between the lateral and third ventricles in 1783. Known as the *foramen of Monro.* It is said that Monro made the discovery in 1753, at the age of 20 (35, p. 239).

Morse, Samuel Finley Breese (April 27, 1791-1872) *Oil Paintings*

Two years later [March 1813, age 21] he was awarded—at the hands of the Duke of Norfolk—the Gold Medal of the Adelphi Society of Arts for a model of the figure of Hercules. This he executed in order to complete with greater effect his picture (which measured 8 ft. by 6 ft. 6 in.) "The Death of Hercules." His painting was exhibited at the Royal Academy Exhibition at Somerset House, and in a letter (24th March, 1813) to his parents Morse mentioned that he not only had the satisfaction of having the picture accepted, but also of having the praises of the Council who decide on the admission of pictures.

"Six hundred pictures were refused admission this year," he wrote, "So you may suppose that a picture must possess some merit to be received in preference to six hundred!" (17, p. 67f).

Peyer, Johann Conrad (1653-1712) *Anatomy*

Johann Conrad Peyer, Swiss anatomist and naturalist, 1653-1712, described elevated nodules in the mucous membrane of the small intestine, chiefly in the ileim. Noted in 1673 [age 20]; published in 1677. Known as *Peyer's patches* or *nodules* (35, p. 278).

The "glandular" patches which Peyer described in his "Exercitatio anatomica-medica de glandulis intestinorum, earumque usu et affectionibus," (Anatomical-Medical discourse regarding the glands of the intestines, their function and affections) Schaffhausen, 1677, were first observed in 1673 [age 20] in the intestines of the cat. He assumed these patches to be truly secretory and imagined that they provided a supplementary pancreatic juice at a location where the efficacy of the latter had been exhausted (29, p. 65).

Pfaff, Christian Heinrich (1773-1852) *Physics*

This table which Volta applied was the voltage series several of which he had set up. This circumstance as well as the additional fact that at about the same time, Pfaff in 1794 [age 21] had also set up such a table which showed as little agreement with Volta's tables as Volta's tables did among themselves, proved how little was known at that time regarding the conditions under which one could obtain reliable values. However, Volta's experiments caused him to recognize that the lasting electrical effect appeared only with two metals having a moist layer between then (11, p. 359).

Priessnitz, Vincent (1799-1851) *Hydrotherapy*

At the age of 18, he instituted his water cure for disease, a treatment which soon found many adherents among the high and the low, the rich and the poor (28, Vol. 2, p. 872).

Prout, William (1785-1850) *Chemistry*

He was an active worker in physiological chemistry, and found in 1803 [age 18] that the acid contents of the stomach contain hydrochloric acid which is separable by distillation (9, Vol. 18, p. 637).

Purmann, Matthäus Gottfried (1648-1721) *Blood Transfusion*

He treated intestinal wounds with simple sutures, employed bimanual examination for stone, and, in 1668 [age 20] carried out the first blood transfusion in Germany, using the blood of a lamb (28, Vol. 1, p. 561).

Reis, Philipp (1843-1874) *Practical Invention*

There can be no doubt that the honor of discovering the telephone belongs to Philipp Reis (1843-1874). With his apparatus, for which Wheatstone first introduced and publicized the name telephone, he was at first able to transmit only tones, later, however, also melodies and—though imperfectly—spoken words. Reis's telephone was exhibited in 1863 [age 20] at a convention of scientists in Stettin, and was widely known in its day. The public and scholars of Germany didn't have sufficient understanding of its far-reaching implications so that, after the death of its disappointed discoverer, it was soon forgotten. It was not until many years later, after the telephone of Bell, who knew how to publicize his discovery adequately, was hailed by us with extraordinary enthusiasm, that Reis was remembered. The Englishman, Thompson, who subsequently examined Reis's apparatus, emphasized in a book written by him that Reis had discovered not only the telephone but also the microphone (18, Vol. 2, p. 345).

Remak, Robert (1815-1858) *Neurology*

In 1836 [age 21] he published an article entitled "Preliminary Announcement of microscopic Observations dealing with the inner Structure of the Cerebrospinal Nerves and the Development of their rudimentary Form," in the *Arch. f. Anat. Physiol. u. wissensch. Med.* (Berlin) (32, p. 82).

Renault, Louis (1877-1944) *Practical Invention*

This account would not be complete without some mention of the work of the Renault brothers of Billancourt, France, and more particularly that of Louis Renault. Towards the end of 1898 [age 21], being dissatisfied with the performance of his 1¾ De Dion-Bouton tricycle, Louis removed the air-cooled engine and fixed it in a four-wheeled car of his own design. . . . From this original car, with its small air-cooled engine, the whole of the vast Renault business was developed in the early years of the twentieth century. A standard design was soon evolved and remained basically unaltered for many years, although a great variety of different models and sizes of cars were produced all having a strong family resemblance, and all of them incorporating the basic features embodied in the first experimental car of Louis Renault (38, Vol. 5, p. 433f).

Ritter, Jacob P. (1862-1896) *Pathology*

Psittacosis, a respiratory disease first recognized in the parrot family, was first detected (1879) [age 17], by Ritter, a Swiss, in seven persons after contact with tropical birds (6, p. 802).

Ritter, Wilhelm (1847-1906) *Architectural engineering*

In 1863 [age 16] Wilhelm Ritter (1847-1906) produced his method of sections which enabled the stresses in a truss to be calculated (38, Vol. 5, p. 501).

Schering, Ernst Christian Julius (1839-1897) *Physics*

Weber demonstrated that all deduction phenomena are deductible from Weber's law (*Abhandl.* Leipzig, **1**, p. 310, 1852). Thereafter, by calculating the potential, E. Schering (1839-1897) [age 19] was able to derive Neumann's law from Weber's law (*Poss. Ann.*, **104**, p. 266, 1858) (19, p. 461).

Semmola, Mariano (1831-1896) *Pathology*

Mariano Semmola (1831-1896), son of an eminent physician, was noted for his clinical and experimental study of Bright's disease (1850) [age 19], and for his work in diabetes and in experimental pharmacology (6, p. 841).

Surtürner, Friedrich Wilhelm (1783-1841) *Anesthesia*

In 1805 the German Apothecary Friedrich Wilhelm Sertürner (1783-1841), then 22 years of age, published his first paper about the "principium somniferum" (somniferous principle), found by him in opium in 1803-1804 [ages 20-21] (21, p. 346).

The alkaloids were quite early scientifically investigated. The pioneer was Friedrich Sertürner (1783-1841), pharmacist at Paderborn, Einbeck and Hameln. As a 21-year-old pharmacy apprentice he proved that the "somniferous principle" of poppy juice was not contained as was believed in a resin-like substance but that the effective component was a crystallizable basic substance which forms salts with acids. He published his results in 1805 and, after a thorough investigation, in 1817, Sertürner named the substance morphine after Morpheus, the Greek God of dreams (25, p. 198).

Smith, John Lawrence (1818-1883) *Chemistry Laboratory tests*

In his student days, Smith had devised a very delicate and most interesting test for the detection of barium, having also determined its quantitative value. This occurred in 1839 [age 21], and probably there are many whose eyes will rest upon these lines who, like the writer, followed the method with his own students in analysis fifty years later (3, p. 76).

Smyth, Piazzi (1819-1900) *Technology*

In 1839 [age 20] the astronomer Piazzi Smyth (1819-1900) . . . constructed an apparatus for producing cold by the expansion of compressed air (38, Vol. 5, p. 46).

Solvay, Ernest (1838-1922) *Chemistry*

At the age of twenty-one, while a helper in a gas factory of Brussels, he developed the process which revolutionalized the soda industry and displaced the LeBlanc process (40, p. 234).

Stensen, Neils (1648-1686) *Physiology*

The action of the muscles accords with the ordinary laws of mechanics. In antiquity this was perceived with some clearness by Galen. He knew of such mechanical laws as those of the lever and the pulley set forth by Archimedes. Galen applied them to muscular action.

In the seventeenth century, the impetus given to the science of mechanics by Galileo encouraged attempts in the same direction. The principle of the parallelogram of forces was applied to muscles in general by Niels Stensen (1667) [age 19], and to the muscles of respiration in particular by John Mayow (37, p. 401).

Stensen, Niels (1648-1686) *Palaeontology*

In due course it came to be recognized that fossils were the remains of forms that had been alive during earlier periods of time: but in reaching this position there was continual controversy. . . . The work, however, that approached more nearly to scientific demonstration was that of Steno. . . . In reference to his work in geology, his conclusions regarding fossils (1669) [age 21] were based on the dissection of the head of a shark, by which means he showed an almost exact correspondence between certain glossy fossils and the teeth of living sharks. He applied his reasoning, that like effects imply like causes, to all manner of fossils, and clearly established the point that they should be regarded as the remains of animals and plants. The method of investigation practiced by Steno was that "which has consciously or unconsciously guided the researches of palaeontologists ever since" (26, p. 322f).

Syme, James (1799-1870) *Applied chemistry*

. . . in his experiments at the age of eighteen he discovered a solvent for india-rubber and the waterproofing properties of the solution. His discovery was applied in industry by Charles Macintosh, who patented the process for rendering cloth waterproof with rubber solution (8, p. 608f).

At the age of seventeen [sic!] he discovered that naphtha would dissolve rubber, thus opening the way to rubberized clothing—still known as 'Macintosches'—after Charles Macintoch who patented the process (12, p. 31).

Taliaferro, Valentine Ham (1831-1888) *Surgery*

Valentine H. Taliaferro, American surgeon, 1831-1888, is credited with performing the first episiotomy in America, on December 2, 1851 [age 20] (32, p. 154).

Tasso, Torquato (1544-1595) *Poetry composition*

At the age of seventeen he gained recognition as a poet by the publication of *Rinaldo,* an imitation of Aristo (36, p. 534).

Thillays-Platell, Antoine (1782-1806) *Electric therapy*

Antoine Thillays-Platell (1782-1806) outlined in 1803 [age 21] simple electrical therapeutic procedures (13, p. 60).

Torrey, John (1798-1873) *Chemistry*

In 1818 [age 20], he issued a paper on . . . 'Vauquelinite in the United States (39, p. 220f).

Vesalius, Andreas (1514-1563) *Anatomy*

In 1536, when Vesalius was 21, he assisted Guinterius in the preparation of his *Institutiones anatomicae,* which was described as an apitome of anatomy based on Galen. Guinterius was primarily a scholar rather than an anatomist, and there is little doubt that most of this work, particularly the dissections, were from the head of Vesalius (28, Vol. 1, p. 404).

Wachter, Georg Heinrich (1790-1864) *Surgery*

In 1810 [age 20] he published a treatise on the removal of joints, especially the removal of the knee joint. "Diss. de articulis exstirpandis, imprimis de genu exstirpato. Groningae, T. Spoormaker, 1810" (32, p. 245).

Ward, Frederick Oldfield (1818-1877) *Osteology*

At the age of twenty, while still a medical student, he published his *Human Osteology,* one of the most remarkable books in the long history of anatomy.

The volume was the size and shape of a small prayerbook, but what it lacked in size it made up in substance. The simplicity of its prose and illustrations is something rarely found in our expensive texts today.

In the preface, Ward says that his little volume was the product "partly of researches in the museum and dissecting room, prosecuted at intervals during the last five years: partly of a careful perusal and comparison of the best English and foreign works on the subject" (12, p. 24).

Weber, Eduard Friedrich Wilhelm (1806-1871) *Physiology*

In 1825 [age 19] in collaboration with his brother Ernest Heinrich he measured the velocity of the pulse wave. This was the first such measurement to be made (32, p. 55).

Wedgewood, Thomas (1771-1805) *Luminescence*

In one of the last comprehensive papers of the century (1792) [age 21] Thomas Wedgewood (1771-1805), son of the famous potter, Josiah Wedgewood (1730-1798), and a potter himself, made a special study of thermo- and triboluminescence. He compared the ability of a great variety of substances, inorganic and organic, to luminesce when placed on an iron plate heated to below the temperature of a red glow, and also tested their response to attrition by rubbing two pieces together. On heating he found blue fluospar to be brightest, giving a green light changing to lilac. Then came red feldspar, various marbles, chalk, and ruby powder with a red to orange luminescence, diamond and sea shells with a white luminescence. Quartz, iceland spar, and white porcelain also showed a white luminescence (15, p. 370f).

Wolff, Caspar Friedrich (1738-1794) *Animal Embryology*

At the very time when Linnaeus was occupied with his fanciful analogies, a young student of medicine named Caspar Friedrich Wolff, who was destined to become a biologist of great note, published a thesis which he called *Theoria Generationis* (Halle, 1759) [age 21]. This thesis marks an epoch in the history of animal embryology. . . . (30, p. 103).

The German, Caspar Friedrich Wolff, produced at 21 his remarkable booklet, *Theoria generationis* (Halle, 1759) (37, p. 462).

Würtz, Felix (1518-1574) *Paediatrics*

In 1538 [age 20] he published the first work dealing with infant surgery (32, p. 345).

C. DISCUSSION

The reader may have noticed that one mathematical contribution only, that of Bolyai, appears in the preceding list. This is because one of my earlier compilations was devoted solely to the achievements of youthful mathematicians (23, pp. 180-183). A second collection of great contributions (23, pp. 200-217) made by mere youngsters was also weighted—in favor of contributions to science—because, shortly before preparing it, I happened to be reading extensively in the history of science. Reflecting my current interest in the history of medicine, the list in this article contains a preponderance of contributions to medical progress. I mention this to point out that it would not be valid to employ these studies for identifying the field or the fields in which young workers are most likely to be early achievers.

In *Life Magazine* for November 9, 1962, there appeared a thumbnail sketch of a 16-year-old boy who has shown an extraordinary ability to hit clay pigeons with a shotgun. In 1962 he broke 249 clay birds out of 250 against the world's best marksmen at the world championship skeet tournament. At another meet he faced 240 grown men, missed only two pigeons out of 400 and beat his 240 competitors. With his mousetrap reflexes, this lad could sight on a bird before it had flown very far, thus gaining an edge on his opponents.

Feats such as that have high visibility and are likely to be widely publicized; hence everyone knows that ability at various sports varies enormously from individual to individual. Not so well recognized is the fact that individual variations in creative ability are also enormous. Physical and intellectual skills are similar in that either of them can appear at surprisingly young ages. They differ, however, in that, unlike intellectual know-how, the typical physical ability, however admirable and even important it may be in a particular situation and for a certain purpose, does not and cannot reach far into the future. Whereas, the individual physical skill is likely to yield only a here-and-now achievement, intellectual finesse may produce dividends for all mankind and for all future time.

In this study I have illustrated the fact that genius sometimes manifests itself in early work of great significance. In commenting upon the fact that young persons have achieved so much creatively and that the highest creative production rate occurs prior to age 40, the late Lewis Madison Terman once remarked: "The lesson for us from Lehman's statistics is that the young of high achievement potential should be well trained for his life work before too many of his most creative years have passed" (41, p. 226).

This problem is all the more difficult because, since knowledge is increasing at an exponential rate, it can be solved only on a temporary basis.

In pondering what has been set forth, it should *not* be inferred that highly significant creative work has not been done by *elderly* individuals. As has been shown elsewhere (23), any stereotyped conception of later maturity is wholly untenable. Individual differences at each and every age level are so large and so numerous that careful study of individual output should be the court of last appeal. Such study reveals a good many individuals who have had both good minds and the physiologic luck that enables them to go on throughout their entire lives doing (or completing) very notable creative work (23, pp. 220-240).

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DEVELOPMENT AND APPLICATION OF AN OBSERVATIONAL METHOD: A PILOT STUDY OF THE MOTHER-INFANT RELATIONSHIP IN PIGTAIL MONKEYS*[1]

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A. INTRODUCTION

The development of practical, reliable, and objective methods for securing detailed observations of ongoing and (particularly) of social behavior—and the related process of recording and analyzing such events in relation to each other—have long been basic problems in a large number of research approaches. There have been frequent references in sociological, psychiatric, psychoanalytic, psychological, and ethological literature to dissatisfaction with the methods so far available for making systematic observations (1, 6, 10, 14). A number of investigators have attempted to develop observational techniques more adequate to their needs (3, 5, 12, 13). The problems are far from solved, but many believe that if more refined observational techniques can be developed such techniques will provide an important avenue to investigation of the processes involved in social development and interaction.

The general method described in this paper provides detailed and quantified descriptions of ongoing behavior and social interactions between two subjects and provides sensitive process analysis of the course of this behavioral development.

B. GENERAL RESEARCH METHOD

In developing the general method, many specific techniques have been integrated within the framework of four basic principles. First, the situation in which behavior is observed is kept relatively simple with environmental control. Second, clearly defined behavioral units of observation and analysis

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are employed. Third, because reliability of observation is not necessarily constant, reliability must be demonstrated throughout the course of study. Finally, some form of quantitative process analysis of the development in behavioral sequences is a requisite of the method.

1. *Environmental Control*

Even though environmental restrictions and controls undoubtedly influence development, they do provide the simplification of "real life" conditions necessary for the development of reliable methods for analyzing complex social relationships. Furthermore, the effects of experimental manipulation of specified environmental variables can be analyzed more meaningfully in terms of variations from baseline behavior. Kuehn and Beach (11) and Bijou (4) have pointed to the advantages (in this kind of "normative" use) of baseline studies performed under controlled conditions. Depending upon the purposes of research, control may be related to such environmental variables as the social history of the subjects, the physical setting in which they are placed for observation, and the "living" situation.

2. *Identifiable Behavioral Units*

Any application of an observational method rests upon the assumption that much spontaneous behavior occurs in the form of identifiable units. For purposes of studying social interaction, these behavioral units should consist of the observed behavioral act designated in terms of three components (referrents): (*a*) the physical position of the subjects in relation to each other, (*b*) the behaving organism, (*c*) and the orientation or focus of the behavior. Furthermore, for convenience in analysis, the discrete motor acts may be classified within broad *behavioral dimensions.* For example, locomotion may be considered such a dimension; it may of course contain some behavioral acts involving approach and others involving departure and, therefore, cannot be construed as identical with a psychological continuum.

Given this general observational structure, specific objective data can be obtained with a coding system that assigns an abbreviated symbol to each behavioral act and its referrents, according to a unique set of discrimination standards. For sequences of behavior to be analyzed, the data must be recorded along a time line, the unit of which would be determined largely by the latency involved in recording observations. Preliminary survey and study has provided convincing evidence that simultaneous recording of verbal symbols and units of time on a magnetic tape recorder is the most flexible procedure for obtaining data. This vocal recording of verbal symbols, consisting of short combinations of letters selected for their cue value, has three major advantages over other methods: (*a*) it draws upon verbal skills (with feed-back) already highly developed in potential observers; (*b*) it provides, for all practical purposes, an inexhaustible supply of codes; (*c*) it permits the observer to focus uninterrupted visual attention on the behavior; thus tending to decrease latency in recording observations.

3. *Continuing Study of Reliability*

In such a system, each code can be given an operational definition and the reliability of applying code definitions can be determined through tests of intra-and interobserver agreement. An important feature of this method is that such tests are made throughout the course of the study. Using a method of recording observations of filmed behavior on magnetic tape, the same observer can code the same block of behavior at separated periods of time until satisfactory intraobserver agreement is achieved. Two observers can code the same behavior independently along the same time line on a dual-channel tape recorder with the simple addition of two headphones into which white noise is fed. The interobserver tests of agreement should be scheduled randomly throughout the study so that each possible pair of observers simultaneously scores the behavior of each subject pair on a randomly distributed sample of observation periods.

A conservative reliability measure, requiring few assumptions with respect to validity, is the simple Agreement Percentage (*A.P.*) (11). Percentages can be derived for the observers as a group as well as for each observer in relation to the others. It is also possible to analyze agreement in coding each behavioral unit, the units making up a given dimension, the behavior of each subject, and the overall behavior of all subjects observed.

4. *Process Analysis*

An important assumption of the method is that recurrent groupings of temporally related behavioral units can be identified as either *individual* or *interactive* patterns of behavior. Furthermore, if observations are sufficiently complete and continuous, and are made at frequent intervals, it is believed that changes in the frequency, duration, and sequential ordering of these patterns will reflect behavioral processes involved in the development of such relationships.

For purposes of this kind of analysis two related organizations of the data are suggested: (*a*) a tabulation of code frequencies occurring in blocks of time. For specified purposes some of these frequencies may also be combined (e.g., by dimension); (*b*) a tabulation of recurrent patterns of codes and of dyad, triad, etc., sequences of such code patterns. This may be performed either by inspection or on the basis of correlation techniques.

While the specific combinations of behavior patterns to be analyzed statistically would be determined largely by the focus of the study, some explanation of pattern concepts that might be developed is in order. To illustrate, consider a simple hypothetical observation (presented descriptively rather than in code) of the behavior of a mother and her child. The two are seated side by side in close physical contact. The child faces the mother and leans against her; mother puts an arm around him. On another occasion the above behavior is observed with the exception that the mother does not cradle the child. On a third occasion, the pair is in the same position and the mother is cradling the child, but he is looking at a picture book. On the basis of inspection, each of these sets of behavior may be designated as a *Pattern,* in that each describes sequences of behaviors. Because each pattern reflects the common aspects of touching, contact, and quietude, all may be defined as belonging to one *pattern group.*

Assuming the research focus to be on interactive relationship, two sets of *pattern variants* could be selected for analysis and the three patterns combined accordingly. The first and third patterns contain the variant of mother cradling and the second, of not cradling—or lack of maternal response. Considering the second set of variants, the first and second patterns could be combined on the basis of the infant looking at and leaning against the mother and the third, the infant looking at the book. Analysis could also be made of developments in the sequential ordering of such patterns, pattern groups, or variants.

The observational method allows for statistical analysis of trends. For such analysis, one must be able to assume (of course) that the sample of subjects and the samples of recorded behavior are randomly selected from their respective populations. Subjects may be regarded as blocks; groups of observations, as trials; and with multiple observations of the same subject over time, the simple analysis of variance and trend described by Edwards (7) can be employed. The assumption of homogeneity of variances may be tested according to Bartlett (2).

Application of the general method to a specific problem can be quite clearcut, offering advantages with respect to objectivity, quantification, and dynamic analysis of data. Let us consider now such a specific application in a pilot study devoted to a preliminary development and testing of the method.

C. The Pilot Study

1. *Subject Pairs*

Two multiparous female pigtail monkeys (Numbers 227 and 471) bred in this laboratory, and their infants (a male and a female), were used in the study.

2. *Environmental Controls*

At parturition, each mother-infant pair was placed into a standard observation and living cage 3½′ × 3½′ square by 3′ high, with two sides and the top of clear Plexiglas and the other sides of galvanized metal. Each cage was equipped with a water bottle, a bin for monkey biscuits, a wall-mounted "jungle gym" of expanded wire mesh 18″ × 20″, wood shavings under a wire-mesh floor, and an aluminum milk bowl. Each cage was placed in a sound-shielded room providing a minimum of 53 to 56 decibels of attenuation and fitted with a one-way observation window. Strict control of other animal contact, and of human contact, except for necessary feeding and cage cleaning was maintained.

3. *Observational Procedure*

The only requirements for selecting an observational period were that the animals should be awake and active. To assess the representative character of observations, subject pairs were observed during two 15-minute periods, separated variously in time on predetermined days. Subsequently a comparison of the behavioral measures from the two daily observations revealed no difference between the first and second periods of the day; therefore they were combined for purposes of analysis. Because considerable time and labor is involved in analyzing pattern data by hand methods, only the middle ten minutes of one observation for each day was selected.

Observations were made on the day of birth (Day O), every second day thereafter until Day 34, and then every third day until Day 70. The observation days were divided into five time blocks, the midpoints of which were used to facilitate statistical analysis of trends.

Observation data in verbal code, together with electronically generated tone signals at 15-second intervals, and with a 15-minute duration alarm, were recorded simultaneously on magnetic tape. With few exceptions, all code symbols of the pilot coding system indicated the animal acting, the dimension of the act, and the specific act. In general, the preliminary system was loosely structured, but the pilot study has provided the necessary empirical basis on which a more highly structured system has been developed. The entire pilot code does not warrant presentation, but five examples of individual codes are shown in Table 1.

In Table 1, a sitting posture for the mother is indicated by the symbol MS. The first letter, M, indicates that the mother is acting; the second letter, S, indicates that she is sitting. There was no letter to indicate dimension. The symbol, ITvv, is more complete. The first letter, I, indicates that the infant is acting; the second letter, T, indicates the dimension of the act, i.e., touching the mother; and the last two letters, vv, indicate the assumption of a ventroventral position at the mother's abdomen. When the two codes occur together, MS-ITvv, and both animals are relatively quiet, XX, is added. The symbols, MTc and MTh indicate, respectively, that the mother is cradling and hitting her infant.

TABLE 1
EXAMPLES OF INDIVIDUAL CODES AND PATTERN-GROUP VARIANTS WITHIN THE GROUP
(A SINGLE-PATTERN GROUP: QUIET-ON)

Variant	Code
Mother indifferent or tolerant	MS-ITvv MS-ITvv-XX
Mother retaining	MS-ITvv-MTc MS-ITvv-MTc-XX
Mother rejecting	MS-ITvv-MTh MS-ITvv-MTh-XX

4. *Tabulating and Classifying Behavior*

Two related organizations of the data were performed. (*a*) A complete tabulation of individual code frequencies was made by blocks. For purposes of analysis, the five general dimensions to which behaviors were assigned are distinguished: locomotion, changes in posture, visual contact, physical contact (e.g., manipulating or touching the other animal), asocial or self-oriented activity, and vocalization. (*b*) A comprehensive sample of the observations was analyzed by inspection and tabulated in terms of recurrent patterns of codes and in terms of dyad sequences of such patterns. The focus of this study, behavioral interaction, determined the pattern analysis that was made. After the prevailing code patterns were identified and tabulated, the data were organized within the framework of four related categories. To illustrate, we will consider the referrent of relative position and certain of the pattern groups, pattern group variants, and pattern sequences.

a. Relative position. On-Position (OP): The infant was said to be on the mother when its body weight was on her and there was continual physical contact between the animals. Near-Position (NP): The infant was said to be near the mother when its body weight was *not* on her, but the infant remained within one foot of the mother. Usually there was intermittent physical contact between the animals in this position. Separated-Position (SP): The infant was said to be separated from the mother when the two animals were more than one foot apart and physical contact between them did not occur.

b. Pattern groups. Identified in this study were 10 pattern groups.

(1). *On-Position pattern groups (OG).* Three such groups were defined; one in which the mother was standing with the infant hanging on her, and two in which the mother was sitting with the infant at her (the mother's) ventrum. Illustrative of one of the latter groups are (see Table 1) the six code patterns which together make up the Quiet-On pattern group. The common aspect of interaction in this group is indicated in the codes MS-ITvv, meaning that the mother was sitting with the infant passively facing her (the mother's) ventrum. The order in which codes are listed in the patterns in Table 1 did not necessarily pertain each time the pattern was observed. Also, other coded behaviors might have occurred in conjunction with a pattern group. For example, the following codes were recorded during one 15-second interval; MS-MTc-ITvv-MOy-MOee-XX (MOy-MOee mean that the mother yawns and looks about the cage, but not at her infant). This interval was identified as pattern No. 4 in Table 1.

(2). *Near-Position pattern groups (NG).* Two such groups were identified, one in which the mother was standing and one in which the mother was sitting.

(3). *Separated-Position pattern groups (SG).* Five groups of patterns were identified. In the first, the animals were more than one foot apart and independently occupied. In the second, the mother moved away from the infant. In the third the mother approached the infant and in the remaining two, the infant showed the moving away and approach behavior.

c. Pattern Group Variants. Three variants of the Quiet-On pattern group were identified for analysis. They were based on differing interactive aspects, in this case, on what might be described as differing maternal "responses" to the infant. "Indifferent" or "tolerant" responses by the mother are included in patterns one and two. Patterns three and four include a "retaining" response by the mother (MTc); the remaining two patterns, a "rejecting" response (MTh). Operationally defined, "retaining" behaviors are those that tend to bring the infant closer to the mother; "rejecting" behaviors tend to move the infant away; and "indifferent" behaviors have neither effect, necessarily. These definitions are stated in a very general way, but are used for the sake of brevity.

d. Pattern Sequences. All dyad sequences (i.e., sequences of two-pattern group-variants or of two-pattern groups) were tabulated. From Table 1, it can be seen that an example of the former is MS-ITvv to MS-ITvv-MTc, (i.e., a change from indifferent behavior to retaining behavior, on the part of the mother). Illustrative of the latter is change from one of the On-Pattern groups, such as Active-On, to one of the Separated-Pattern groups.

5. *Continuing Study of Interobserver Agreement*

Three observers recorded data in this investigation. Tests of interobserver agreement were scheduled randomly throughout the 70-day period, so that each of the three possible observer pairs simultaneously scored the behavior of each subject pair once in every block. The figures to be reported have been derived from the combined data for all codes, but agreement on individual codes did not vary greatly.

The overall level of agreement, (i.e., the average *A.P.* for all observer pairs over all animals and blocks) was 74.5 per cent. Separate *A.P.*s for each observer pair, averaged over animals and blocks, ranged from 71 to 74 per cent. For animals, agreement averaged over observer pairs and blocks was 74 and 75 per cent. No systematic block to block variation was found.

Considering the fact that the pilot code was not highly structured or strictly defined and was undergoing modification throughout the period of the study, the level of agreement among observers is reasonably high. More important, and perhaps partly as a consequence of continually checking interobserver agreement, this level varied little, either between observer pairs or over time. For the purposes of the pilot study, the data are regarded as indicating acceptable reliability.

6. *Process Analysis—Illustrative Description*

Several characteristics of infant development and of the mother-infant relationship in pigtail monkeys are obvious to general observation. Infants become active and appear to engage in more kinds of activity as they mature. Although mothers generally are protective toward their infants, the development of independence between the mother and infant seems to begin early in life. Such general observations raise many questions concerning effects of the mother-infant relationship on the course of development and concerning the processes or mechanisms involved in mother-infant interaction. The following selective statistical analysis and description is presented to illustrate how the

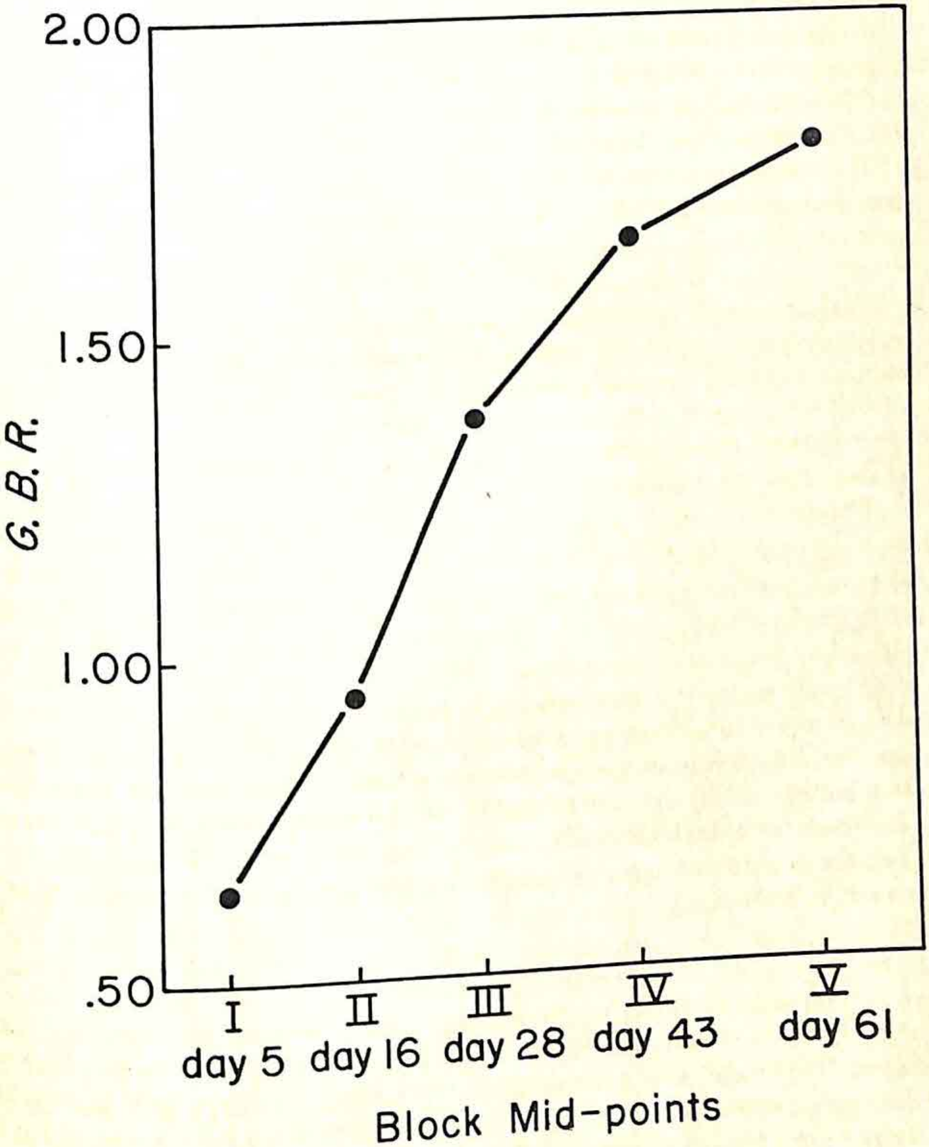

FIGURE 1
Development in the General Behavior Ratio (GBR) in Infants. Based on the Ratio of the Combined Frequency of Infant Behavior Codes to that of Mother Behavior Codes

research method described may provide the means for answering such questions.

Because the description is based on data from only two subject pairs in a highly controlled setting, it is not considered accurate in representing mother-infant behavior in the species studied. Furthermore, although all data were analyzed, the measures included in this report have been selected arbitrarily for illustrative purposes. Effort has been made, however, to avoid misrepresentation of obtained relationships as a result of the selection process. The description is presented in two parts: (*a*) the course of behavioral development, based primarily on an analysis of code frequencies; and (*b*) the development of the interactive relationship, based entirely upon pattern analysis.

TABLE 2
ANALYSIS OF VARIANCE, TESTING DEVELOPMENT OF GENERAL BEHAVIOR RATIO (GBR) FOR INFANTS

Source of variation	Sum of squares	*df*	Mean square	*F*	*p*
Main analysis					
Subjects	.6250	1	.6250	27.90	.01
Blocks	1.8252	4	.4563	20.37	.01
Error	.0894	4	.0224	—	—
Total	2.5396	9			
Trend analysis:					
Linear component (Blocks)	1.7019	1	1.7019	75.98	.01
Quadratic component (Blocks)	.1141	1	.1141	5.11	—

a. Course of behavioral development. One general aspect of behavioral development is indicated by a measure of infant activity in relation to that of its mother. This measure is called the General Behavior Ratio (GBR). Results based on the GBR are presented in Figure 1 and in Table 2. The points of the curve in the figure represent time-block (or trial) averages for the two subject pairs. The table is a standard summary of analysis of variance and trends. The data suggest that infants initially are less active than their mothers. The statistically significant upward trend of the GBR indicates that the infant's activity level rises sharply following birth, surpasses the mother's near the end of the first month, and remains higher than hers into the third month. Separate frequency analyses show that the absolute activity level of the mothers remains stable during this period, and that the increase illustrated in Figure 1 results entirely from a rapid increase in infant activity. The separate analyses also indicate that the significant subject difference shown in

Table 2 is a function of individual differences found in the absolute activity level of the mothers. No such differences are found in that of the infants. Furthermore, no significant quadratic component appears in any of these analyses of general activity.

Our next concern is the question of how the general activity of each member of the pair is distributed along the several behavioral dimensions. Data relevant to this problem are analyzed in a fashion similar to that for the GBR and suggest the following general conclusions. The mother's behavior profiles, though individually different, tend to remain the same over dimensions, while the infant's profiles become modified in important respects. General activity increases in all dimensions, but the proportional dimensional profiles become increasingly like the mother's. For example, the proportion of infant behavior involving contact with the mother decreases, while the relative amounts of behavior coded in the other dimensions increases. These facts clearly indicate that there are several facets in the developments in the dimensional profiles of the infant.

Data such as those illustrated by Figure 2 suggest some of the factors that may be operating in this dimensional elaboration of the infant's behavior. In addition, they indicate some important changes in the mother's behavior (within certain dimensions) as the infant matures. The four measures included in the figure are based on analyses of development within the contact dimension.

The structure of Figure 2 is a prototype for those that follow. Each measure is presented in a separate graph, which has a descriptive title to indicate the derivation of the measure employed. The points plotted in each graph represent block averages for the two subject pairs, and block midpoints are indicated on the abscissa. To make the trends more apparent in a limited space, the ranges covered by the ordinates vary from measure to measure. The nature of these trends is indicated by regression lines, which have been fitted by graphic methods [See Guilford (9)], but are not intended to imply true slopes. A straight line indicates that the linear component of the block sum of squares was statistically significant at an .05 level. A similarly significant quadratic component is shown by a curved line. If block differences were also significant, the trend is illustrated by a solid line and statements in the text are made positively; if not, by a broken line, and textual references are to "tendencies."

With respect to the dimensional elaboration depicted in Figure 2, two significant changes occurred in the mother's contact behavior during the early part of the infant's life (Figures 2-A and 2-B). It is clear that "retaining" is the major mother-contact response to her infant. However, this response

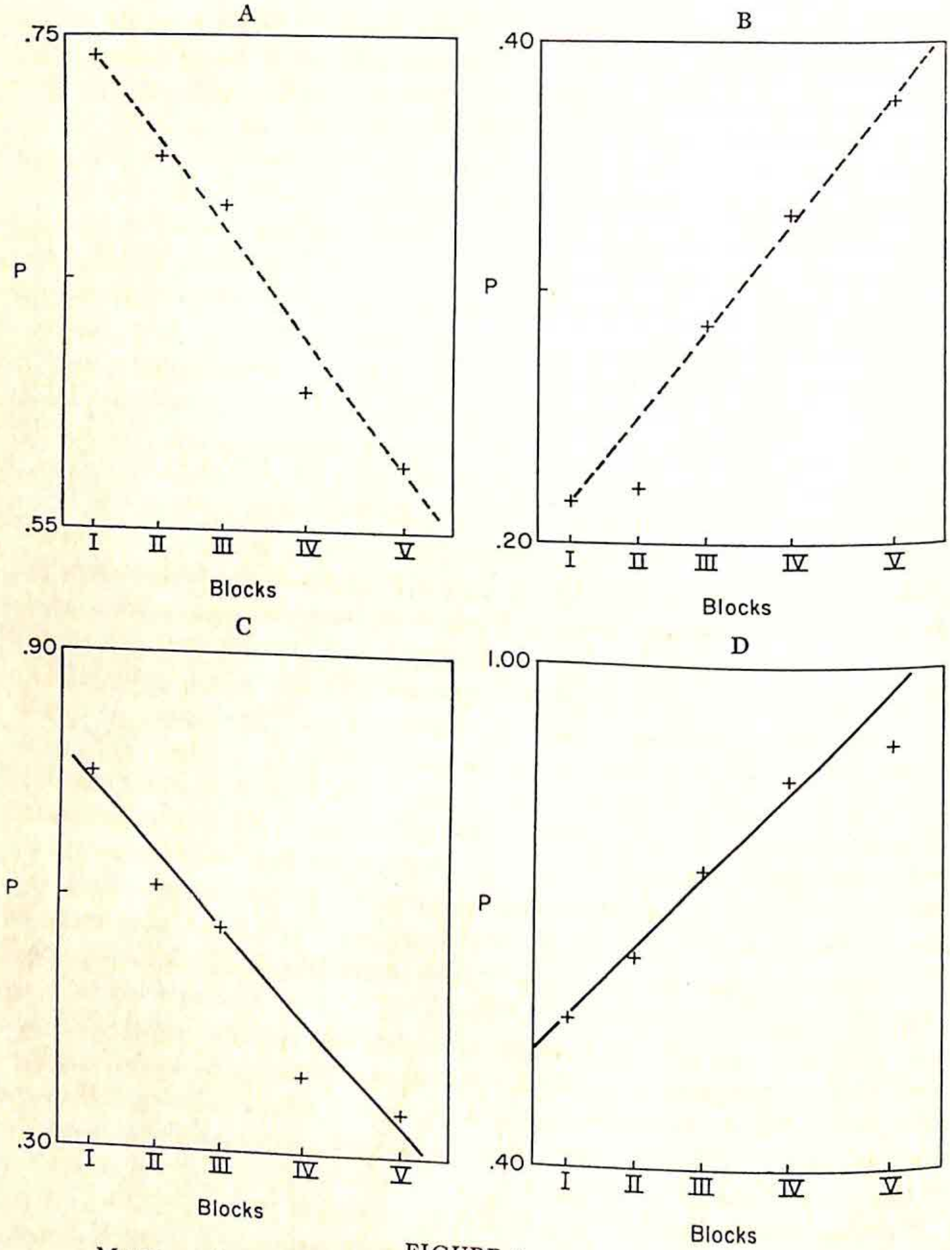

FIGURE 2
MEASURES ASSOCIATED WITH THE ELABORATION OF BEHAVIOR. BASED ON DATA FROM FREQUENCY ANALYSIS OF INDIVIDUAL CODES
(A. Mother Retaining: Proportion of Total-Contact Behavior. B. Mother Rejecting: Proportion of Total-Contact Behavior. C. Infant-Physical Contact: Proportion of All Behavior. D. Infant Active Physical Contact: Proportion of Total-Contact Behavior)

tends to decrease, while rejecting behavior tends to increase as the infant grows older (Figure 2-B). Turning to the amount of infant behavior involving contact with the mother, it is seen that it's proportion, relative to total behavior, decreased (Figure 2-C). Furthermore, the proportion of infant contact behavior that is active increases rapidly over the first two months, from approximately half to over 90 per cent (Figure 2-D).

Summarizing briefly, the foregoing and similar analyses of other dimensions indicate the following principal developments in the elaboration of behavior: (*a*) The infant shows increasing general activity, including that during periods of physical contact with the mother. (*b*) Physically and visually, the infant contacts the mother relatively less often. (*c*) The mother tends to respond to the infant's increasingly active contact behavior with a greater proportion of rejecting behavior. (*d*) More of the mother's locomotion involves departing from the infant. And (*e*) less of the mother's locomotion involves carrying the infant around with her.

Having seen that general decrease in infant-contact behavior is an important variable in development, some process of separation is suggested. Insight into this process may be provided by data on the amount of time spent in each of the relative positions. Our data were analyzed in terms of the proportion of the total number of 15-second intervals within a time block that the mother and infant spent in a relative position. Three conclusions are warranted. Immediately after birth, the infant spends most of its time on the mother; but progressively less time is spent there as the infant matures. Time in the Near-Position increases throughout the study and this trend is still accelerating positively at the end of 70 days. Time in the Separated-Position appears to increase but, during the period covered by this study, the increase is not statistically significant. From these facts, the Near-Position does in fact appear to represent an intermediate stage in a process leading to mother-infant separation.

b. Developments in mother-infant interaction. By analysis of behavior patterns, it should be possible to suggest something of the nature of the interaction processes and of their effects on the behavioral development illustrated. Figure 3 presents several pattern measures dealing with interactive variables in the On-Position.

Turning first to the early period of the infant's life (Block I), Figure 3-A suggests that the mother's behavior may reflect physiological readjustment from pregnancy and parturition to motherhood. At least the mother responds indifferently to a quiet infant relatively more often than she does in the next and succeeding blocks. For the infant, this period of initial adaptation is characterized by close physical contact with the mother (for periods averaging 5.25 minutes in duration). The infant remains quiescent over half of this time (Figure 3-B). More than 50 per cent of the quiet periods are followed by activity while still on the mother (Figure 3-C), but this usually leads back to further periods of Quiet-On behavior (Figure 3-D). Almost all Active-On periods proceed from Quiet-On rather than from Near or Separated periods (Figure 3-E), and are rarely followed by transition to the Near-Position (Figure 3-F). In general, little movement away from the protective ventrum occurs during the first week of life.

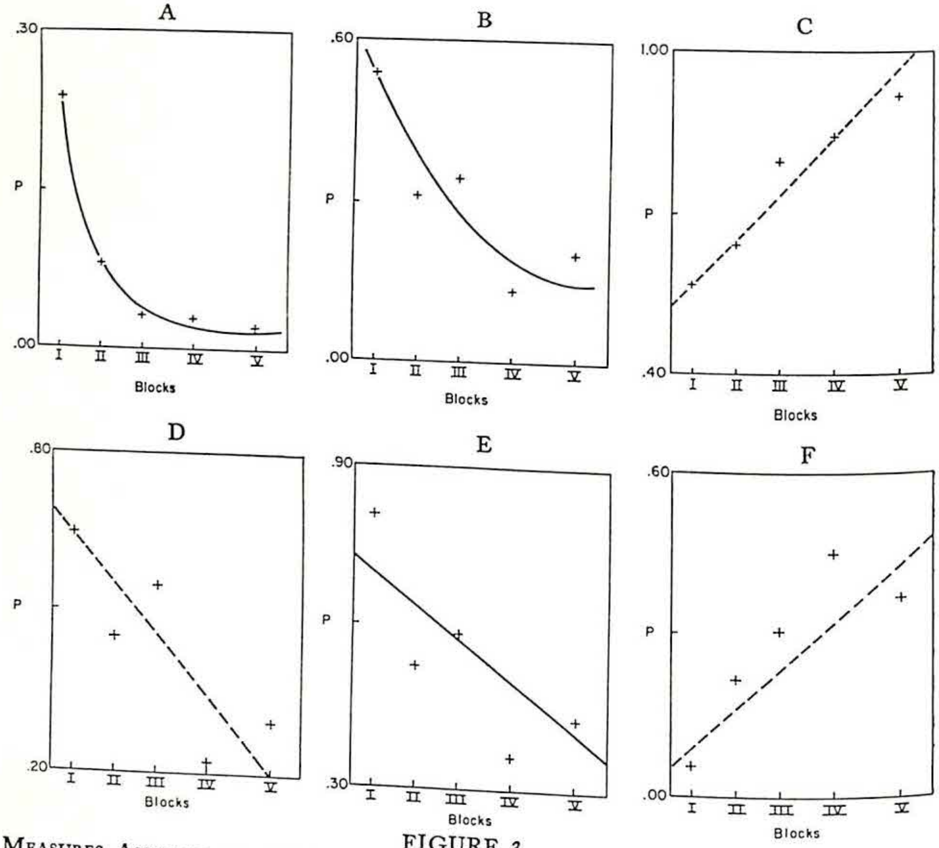

FIGURE 3

MEASURES ASSOCIATED WITH INTERACTIVE DEVELOPMENTS RELATED TO THE ON-POSITION. BASED ON DURATION AND TRANSITION DATA FROM THE PATTERN ANALYSIS

(A. Infant Quiet-On, Mother Indifferent: Proportion of Total Intervals Spent in On-Position. B. Infant Quiet-On: Proportion of Total Intervals Spent in On-Position. C. Infant Transition from Quiet-On to Active-On: Proportion of Total Transitions from Quiet-On. D. Infant transition from Active-On to Quiet-On: Proportion of Total Transitions from Active-On. E. Infant Transition to Active-On from Quiet-On: Proportion of All Transitions to Active-On. F. Infant Transition from Active-On to Near: Proportion of All Transitions from Active-On)

The interactions that relate to the development of separation and increased infant mobility now must be considered (Figures 3 and 4). Although infants spend progressively less time on their mothers, we see that they are becoming more active when they are in this position (Figure 4-A). After Block III, however, it must be noted that the pattern of being Active-On the mother becomes a less prominent part of their total behavioral picture (Figure 4-B). Furthermore, the close alternating relationship between quiet and active periods on the mother weakens during this stage; the infant continues to go increasingly often from a Quiet-On to an Active-On position (Figure 3-C), but less frequently from Active-On back to Quiet-On (Figure 3-D), and less often does behavior in the Active-On position follow from Quiet-On (Figure 3-E). Instead, there begins to develop a tendency that involves transitions

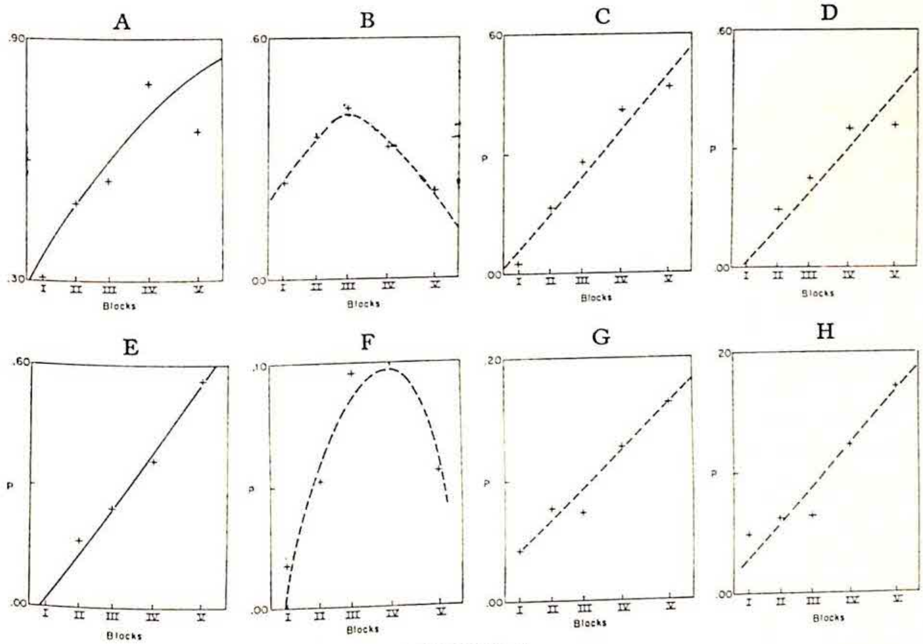

FIGURE 4

Measures Associated with the Interactive Developments Related to Separation and Independent Behavior. Based on Duration and Transition Data from the Pattern Analysis

(A. Infant Active-On: Proportion of Total On Intervals. B. Overall Infant Active-On: Proportion of Total Intervals in a Block. C. Infant Transition from Active-On (Mother Indifferent) to Near: Proportion of All Transitions from this Variant. D. Infant Transition to Active-On from Near: Proportion of all Transitions to Active-On Position. E. Infant Transition to Active-On (Mother Indifferent) from Near: Proportion of All Transitions from Near-Position. F. Transition from On to Near: Proportion of Total-Pattern Group-Sequences. G. Transition from Near to Separated: Proportion of Total-Pattern Group-Sequences. H. Transition from Separated to Near: Proportion of Total-Pattern Group-Sequences) between activity on the mother and activity in the Near-Position (Figure 3-F). The mother increasingly reacts indifferently when the infant returns from the Near-Position (Figure 4-E). When she does react indifferently (or with tolerance), the infant tends to return more often to the larger environment (Figure 4-C).

As mentioned earlier, analysis of the proportion of time spent in the three relative positions shows that the curve of the Near-Position proportion is positively accelerated. In fact, by Block V, the infant was spending more time near and separated from the mother than on her. Transition behavior also shows changes in the direction of greater separation. Movements from the On- to the Near-Position tend to become relatively less frequent during the second month (Figure 4-F), while those going in both directions between the Near- and the Separated-Positions, increase to the end of the study (Figures 4-G, H). It appears evident that the interactive factors analyzed and illustrated are closely related to the variable defined as physical separation and possibly reflect psychological independence.

Pattern analyses, similar to those illustrated, were made for the Near- and Separated-Positions. These data are not presented, but it should be noted that they show each of the animals continuing to have a role in the separation process.

D. Methodological Summary and Discussion

The general method presented should be appraised in terms of the basic principles that governed its development: a simplified setting, discrete coding of behavioral units, continual reliability testing, and a principle of process analysis.

Isolation of subjects from other members of their species simplifies as well as complicates research. It simplifies the problem of securing continuous, complete, and reliable observations of behavior. It highlights such interactive processes and developmental sequences as do occur. For example, even the limited data and analysis presented show something about the way the two animals influence each other behaviorally. Of course, data collected under such environmental restrictions cannot be regarded as normative in the sense of providing developmental schedules for mother-infant behavior in a natural setting; they do, however, provide useful baselines for analyzing and interpreting the effects of experimental manipulation.

The behavioral-unit coding-system used in the pilot study was loosely structured in that the referrents of each behavioral act were not sufficiently defined in the code symbols. In particular, both dimension and orientation were represented by a single symbol in most codes, and several codes served to indicate both relative position and a behavioral unit. Such confoundings in the coding system were expected, but the advantages of structuring the final system on empirical grounds outweighed this factor. It was felt that such structuring in the absence of empirical findings might bias the description of the mother-infant relationship.

The reliability level for the pilot code was respectable, though perhaps not as high as it should be in a full-scale substantive study of mother-infant relationships. This appears to be largely a function of the "loose" structure of the pilot code and of inadequate observer-training procedures. Continuous reliability testing demonstrated that a set of trained observers can maintain a consistent level of agreement over a long period of time. This may be because such continuous testing provides important motivation in keeping observers alert. The procedure is recommended, for demonstrating consistent reliability makes it possible to combine data from all observers and to compare data gathered early in a study with those gathered later.

The illustrative material presented indicates that the behavior-pattern concept provides a useful tool for analyzing interactive relationships. In general it extends and makes more meaningful those analyses based on developmental changes in individual code frequencies, but by focusing attention on relationships between particular behavior codes the interactive processes that effect these changes are highlighted. In addition, pattern analysis reduces the number of units of information that must be assimilated interpretively. This is an important advantage, in view of the fact that more than 3,500 code units have been recorded in a single block for one animal pair.

In the present study, patterns were identified by visual inspection. In the future, when computer techniques are employed, the authors plan to determine the behavioral-unit composition of these patterns on the basis of intercorrelational techniques. In this way, both the general concept of the behavioral pattern and the specific pattern compositions to be analyzed will acquire clearer operational definition.

Finally, the use of trend analysis is a useful procedure in such developmental studies as the one outlined. The application of this technique to the data has been made possible by careful attention to reliable quantification and random sampling. The modified split-plot design that has been used is admittedly controversial in that it involves repeated measures of the same subjects (7, 8). Nevertheless, for descriptive studies of the kind contemplated and with rigorous qualification of interpretative statements, the design is regarded as appropriate.

In summary, the method warrants further application. While the pilot study cannot be regarded as substantive, it is clear that the method can produce reliable quantitative measures of social relationships. It is suggested that the general method can be adapted, through appropriate modifications, to a broad range of observational investigations.

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EFFECTS OF DELAY ON THE MAINTENANCE OF FIXATED BEHAVIOR IN ALBINO RATS*[1]

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A. INTRODUCTION

Investigations in the area of fixated behavior in animals have centered upon problems associated with pain-fear reactions and upon notions of "therapy" to overcome the tendency of the fixated response.

With respect to pain-fear reactions, Estes (1) observed a heightened resistance to extinction of a goal-oriented response by including nonshock trials within a shock schedule. Jones (3) similarly demonstrated that a running response in an intermittent-escape situation was more resistant to extinction than a running response under escape conditions alone.

In addition, "therapeutic" techniques in the form of guidance [Maier and Klee (4)], competing food-motivated responses [Farber (2)], and stimulus variations [Moltz (5)] have been empirically demonstrated to alter the fixated responses.

In the present investigation, both escape and intermittent-escape schedules were utilized to produce pain-fear reactions; and a response-reversal criterion was used to estimate response repetition under the two escape schedules and to determine the effectiveness of delay periods in overcoming repetitive responses, when a delay chamber is interspersed between an electric-grid stem and the choice-point of a Y maze.

Several hypotheses were advanced: (*a*) that escape and intermittent-escape schedules produce response fixations, (*b*) that the intermittent-escape schedule produces a greater degree of response fixation than the escape schedule, (*c*) that delays in a "therapy" chamber facilitate food-oriented response-reversals, and (*d*) that the number of trials required to produce response reversals are related to the length of the delay periods.

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B. Method

1. *Subjects and Apparatus*

The subjects were 87 naive albino rats (32 male and 55 female) of the Sprague-Dawley strain and were 40 to 60 days old at the beginning of the experiment.

The apparatus consisted of a closed Y-shaped maze with a runway extending 28½ inches to the choice point. The grid floor, beginning in the starting box and terminating in front of the delay area, consisted of ⅛″ thick brass rods placed ¼″ apart. The maze was constructed of wood and was painted flat black. A black curtain draped the entrance to the delay area. Guillotine doors were placed at the starting box, at the delay area, and at the choice point. The entire top surface of the maze was covered with glass, and sliding glass panels were used in the arms of the maze to permit removal of the animals.

The electric shock-inducing apparatus consisted of a zero to 135-volt variac wired to a 110 to 500-volt step-up transformer with a 220,000 ohm, one-watt, fixed resister. The brass rods making up the 20″ grid were connected to two leads, every other rod being positive with intervening rods negative. The shock apparatus was controlled by a single-pole, double-throw (off-on) switch.

2. *Procedure*

a. Adaptation. One week prior to adaptation, the animals were assigned to home cages, were handled frequently, and were given unlimited feeding. The diet in the home cages consisted of Purina laboratory chow checkers.

On the first day of the adaptation series, the animals were introduced to the maze in small groups and were allowed to explore the maze until each animal entered at least one of the arms of the maze. Guillotine doors were not present—only the black curtain and the door allowing entry to the starting box were present. The animals were removed from the arms only. They were not on hunger drive during this phase of adaptation.

The procedure on the second day was essentially the same, but on that day each animal was placed into the maze individually; and the T-shaped guillotine door at the entrance to the arms was lowered behind the animal to prevent retracing and to accustom the animal to its presence and noise. Following a minute of exploration in the arms, the animals were returned to their home cages and were put on a 20 to 23 hour food-deprivation schedule that was maintained thereafter.

For the two days following, each animal was placed into, and was restricted in, the arms of the maze and was given the following adaptation training: (*a*) a food pellet (Calf Manna pellet) was given in the left arm with additional time for exploration (a total of two minutes), and (*b*) this was followed by a pellet in the right arm for another two-minute period. The series was repeated, giving the animals two feeding experiences in each arm on each of the two days. This concluded the adaptation phase of the investigation.

b. Training. Training was given in the acquisition of a preferred position response. Food was placed in both arms on the first trial only. The animal was placed into the starting box and was allowed to enter the stem. Once the animal entered an arm, the T-shaped guillotine door at the choice point was lowered to prevent retracing into the stem or into the opposite arm. The first response was defined as the particular animal's position preference and, thereafter, the animal was reinforced only for its position preference. When animals entered the nonprefered arm of the maze, they were detained for thirty seconds and were then removed. All animals were given ten trials each day for four days, a total of 40 trials. After these 40 trials, the conditions of the two separate experiments were introduced: Experiment 1, under escape conditions (100 per cent shock), and Experiment 2 under intermittent-escape conditions (50 per cent shock).

(1). *Experiment 1 (escape condition)*. At this point, animals were divided into two groups designated control and experimental-shock groups. The animals were assigned to the two groups on the basis of number of non-reinforced trials occurring during the first 40 trials. Sixty additional trials, 10 on each day, were administered to each group. The control group contained 17 animals, and the experimental-shock group contained 37 animals. The procedure for the control group was the same throughout the first 40 trials and for the additional 60 acquisition trials. Electric shock was administered to the experimental group on the 41st trial. The strength of the shock was gradually stepped up to 410 volts. The series employed was as follows: 150 volts on the 41st trial, 250 volts on the 42nd trial, 350 volts on the 43rd trial, and 410 volts on the 44th trial. Thereafter, the animals were given a 410-volt shock on every trial.

During extinction, starting with Trial 101, electric shock was discontinued and the food was switched to the opposite arm. Animals previously reinforced in a particular arm were required to reverse their responses to the opposite arm. This procedure was identical for the control and experimental-shock groups. The experimental-shock group, however, was divided by random means into three subgroups, groups which were to experience 0-second, 5-

second, and 30-second delay-periods during these extinction trials. The delay area was created by enclosing the animals between the T-shaped guillotine door and a guillotine door immediately behind the black curtain; thus the animals were delayed in an 8″ chamber immediately after running off the electric grid. The criterion of extinction was two consecutive response reversals.

(2). *Experiment 2 (intermittent-escape procedure)*. The control group of Experiment 1 was used as the control group for Experiment 2. In this experiment, the experimental-shock group consisted of 32 animals. This group was treated the same as the experimental-shock group in Experiment 1, with the exception that a 50 per cent shock schedule was used instead of a 100 per cent shock schedule. Other than fixing the first and last trials as shock trials, the other shock trials were randomly assigned on each day, by a table of random numbers. Animals were given five shock and five nonshock trials on each of the six days. As in Experiment 1, the voltage was increased over the first four shock trials, beginning with 150 volts on the 41st trial with maximum strength (410 volts) administered on the fourth shock trial. The assignment of subjects to delay groups and the conditions of the extinction trials were exactly the same as in Experiment 1.

C. RESULTS

1. *Experiment 1*

Fifty-four animals were included in Experiment 1. As indicated by Table 1, only 43 animals were included in the treatment of results. Eleven animals adopted a nonfood-oriented response when the shock trials were introduced, and they maintained that fixated response throughout the remaining 60 shock trials. This constituted a loss of approximately 20 per cent of the experimental-shock subjects.

TABLE 1
MEANS, MEDIANS, STANDARD DEVIATIONS, AND *N* FOR THE 100 PER CENT SHOCK EXPERIMENT

Statistic	Control	Group		
		0″-delay	5″-delay	30″-delay
N	17	9	8	9
Median	8	9	6.5	7
Mean	9.12	10.89	7.38	7.11
SD	3.01	3.28	3.60	2.13

The number of subjects in each of the delay groups was approximately the same. The 0-second-delay and the 30-second-delay groups had nine subjects each, and the 5-second-delay group had eight subjects. The control group contained the largest number of subjects, 17. As indicated in Table 1, the means and medians did not give evidence of marked skewness in any of the distributions. The F test for the four experimental conditions was 2.789 which, for 3 and 40 degrees of freedom, falls short of the .05 level-of-significance requirement for rejecting the null hypothesis.

2. *Experiment 2*

Fifty animals (including the control group) were used. Thirty-two animals were run under 50 per cent shock condition. One of these animals had to be eliminated because it adopted a nonfood-oriented response when shock trials were introduced. This constituted a loss of about three per cent of the animals.

TABLE 2

MEANS, MEDIANS, STANDARD DEVIATIONS, AND N FOR THE 50 PER CENT SHOCK EXPERIMENT

		Group		
Statistic	Control	0″-delay	5″-delay	30″-delay
N	17	10	10	11
Median	8	25.5	8.5	7
Mean	9.12	23.5	23.4	6.64
SD	3.01	12.17	12.70	1.93

Results reported in Table 2 indicate that, under 50 per cent shock conditions, the performance of the animals is much more variable. The number of animals in the 0-second delay- and the 5-second-delay groups each equaled 10, whereas there were 11 animals in the 30-second-delay group. Reference to the means and medians in Table 2 indicate that, for all but the 5-second-delay group, the distribution is skewed markedly to the right. The skewness appears to be attributable to the effects of two extreme scores, 53 and 117. The standard deviations of the control, 0-second-delay, 5-second-delay and 30-second-delay groups are 3.01, 12.17, 12.70, and 1.93 respectively. The Kruskal-Wallis one-way analysis of variance by ranks (6) was used as a test for overall significance of the results. An $H = 152.92$ is significant at the .05 level of confidence.

The Mann-Whitney U test (6) was selected to test the differences among the individual groups. Three relationships are significant at the .05 level: (*a*) control < 0-second-delay group, (*b*) control > 30-second-delay group, and (*c*) 0-second-delay group > 30-second-delay group. The mean of the 5-second-delay group is not significantly different from the mean of the control group, 0-second-delay group, or 30-second-delay group.

D. Discussion

The hypothesis that escape and intermittent-escape schedules produce response fixations as well as the hypothesis that an intermittent-escape schedule produces a greater degree of response fixation than an escape schedule are not altogether supported by the results. The findings are in the predicted direction; however response fixation was not observed under escape conditions, although it was observed under intermittent-escape conditions.

Under conditions of the escape schedule, negligible differences are noted between the control and experimental animals in response reversals. Differences among the three delay groups also appear to be minimal. It is reasoned that the apparent lack of significant differences among the three delay groups might be accounted for on the basis of an insufficiently heightened state of drive to be benefited by "therapy" in the form of delay. In other words, under escape conditions (100 per cent shock) the expectancy of shock is confirmed for the majority of trials, so that when shock is terminated at Trial 101, the abrupt absence of the punishing stimulus over a few trials appears to be sufficient to reduce the pain-fear response which was concentrated at the starting point of the maze. Accordingly, response fixation does not occur in this situation, and response reversals are made as quickly with "therapy" as without "therapy."

The hypothesis that "therapy" in the form of delay before the choice point facilitates food-oriented response reversals was testable only in the intermittent-escape experiment (50 per cent shock), for response fixation was observed only under this condition. In the 5-second-delay group, most of the animals shifted their response quickly; but two animals persisted in their escape response for an unusual number of trials. It seems that 5-second delay is a transitional period in which pain-fear reactions are sufficiently reduced (in the majority of animals) to allow response reversals, but that pain-fear reactions remain sufficiently strong in the minority of animals to perseverate the escape response. Because of the limited number of subjects in the 5-second-delay group, it is difficult to appraise the possible reasons for the extended range of responses.

In the 30-second-delay group, the pain-fear reactions appear to be sufficiently reduced to allow the animals to alter quickly their response to the opposite arm containing the food. The performance of the animals in the 30-second-delay group, as compared with the animals in the 5-second-delay group, support the hypothesis that the number of trials required to produce response reversals are related to the length of the delay periods. An interesting finding in relation to the 30-second-delay group is the direction of the difference between this group and the control group. As previously noted, response reversals occur more quickly for the 30-second-delay group than they do for the control group, despite the experience of shock. Apparently, the pain-fear reactions are sufficiently reduced by the 30-second delay to combine with the food-deprivation drive; thus permitting an increase in the strength of the anticipatory eating reactions that, in turn, facilitate the response reversals.

E. SUMMARY

Two separate experiments were run under escape and intermittent-escape conditions. The specific hypotheses tested were (*a*) that escape and intermittent-escape schedules produce response fixations, (*b*) that the intermittent-escape schedule produces a greater degree of response fixation than the escape schedule, (*c*) that delays in a "therapy" chamber placed between the grid and choice point facilitates food-oriented response reversals, and (*d*) that the number of trials required to produce response reversals is related to the length of the delay periods.

The apparatus used was a Y-shaped maze in which the animals were given 100 trials of training to their preferred side. Forty of these trials constituted nonshock trials, the remaining 60 trials were included in the shock series. The escape animals received 60 trials of shock, whereas the intermittent-escape animals received half of the number of shock trials arranged randomly. The experimental animals in both conditions were divided into three delay groups (0-second, 5-second, and 30-second delay) at the end of the training trials. At that point shock was discontinued, the goal was switched to the non-preferred side, and the respective delay periods were instituted. The animals were run to a criterion of two consecutive response reversals.

The findings indicate that animals fixate in their performance under intermittent-escape conditions, but not under escape conditions. Furthermore the effects of the length of delay is in the predicted direction, with response reversals occurring most quickly in the 30-second-delay group, even more quickly than in the control group.

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A STUDY IN RELATIONSHIPS BETWEEN THE LIFE AND DEATH CONCEPTS IN CHILDREN* [1]

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A. INTRODUCTION

Historically, the word "animism" has been made prominent by anthropologists. It implies the distinction between subject and object, between body and soul. Primitive man is thought of as using the concept of animus, or soul, to explain natural phenomena. ("Why does the river speed towards the sea?") According to Radin (5), Levy-Bruhl has discredited this notion of a separation of body and soul in primitive man. He replaces the idea of animism with the concept of mystic participation. This concept refers to the basic undifferentiatedness of primitive man and his environment.

Piaget (4) uses the term "animism" to describe the mental phenomena in children that results in the ascribing of life and life-like qualities to inanimate objects. His usage, however, is the opposite in meaning from that of the early anthropologists. According to Piaget, animism does not arise through a separation of object and subject, but rather through a fusion of the two. The child is fused with the stone to which he ascribes life. The primitive man is fused to the river to which he ascribes volition and purpose.

If one accepts the idea that animism in childhood is due to a fusion of object and subject, one must be prepared to accept the idea that products other than animism may result from the fusion. According to Piaget, animism is the result of a deficient boundary between the child and the objects surrounding him. This view assumes that the child sees objects as extensions of himself. If a child conceives of himself as living and subject to the process of death, then he should conceive of objects as living and subject to the process of death. In this study, the act of ascribing death to an object, the experimenter, *E*, called

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negative animism. The act of ascribing lifelike qualities to an inanimate object, *E* called positive animism.

Piaget (4) and Nagy (3) have found evidence for some developmental principles in the concept formation of life and death. It would seem, from a review of the literature, that a logical linking exists between the developmental principles.

Piaget used the interview method to study the developmental aspects of animism. He distinguished four separate phases of animism in the child. He assumed that conceptions develop in discernible stages that follow a regular sequence related to age. In Piaget's view, the year levels at which the stages appear may vary with individual, cultural, or training differences; but the sequence that the stages follow is unmodifiable and necessary. In his aims of describing phenomena, Piaget does not explain the "why" of the different stages.

Piaget's first model stage in the development of animism is a general activity stage. The child sees as being alive anything that is active in any way. The stove is considered "alive" because "it cooks the meal for us." The second stage shows life as assimilated to movement; thus water is alive because it can move, and clouds are alive because "they travel." Mechanical devices, such as cars and bicycles, are thought of as alive because they move. The third stage sees life as spontaneous movement or movement by itself. The mechanical devices are no longer considered to be alive because they do not "go by themselves," but need an operator. During the fourth stage, the child achieves his adult view on life and restricts its use to plants and to animals. There is no definite, inviolable age limit attached to the different stages, but there is a definite modal development.

Thus, for the majority of Piaget's Swiss children, Stage 1 lasted up to the 6th or 7th year. Stage 2 is placed between the ages of 6 and 8. Between 8 and 11, the child has usually achieved the common adult norms (life restricted to plants and to animals).

Huang and Lee (1) deny any special type of childish logic that would result in different types of animism. For Huang and Lee, the child is different from the adult only to the extent that he lacks information about the "real" world. Huang and Lee's theory might be called a computer theory. The computer can give correct answers to the extent that it has the correct amount of data fed into it. For example, the child thinks about a stone as being alive because he has not been taught otherwise. One can characterize Piaget's theory of animism as a stage-development theory. Strauss (6), in a review of Huang and Lee's data, concludes that they support Piaget's theory.

Nagy (3), independently from Piaget, has found developmental stages in the formation of the concept of death. Her conclusions parallel Piaget's findings. The first stage she describes covers the development of the child up to age 5. During the first stage, the child sees death as a definitive fact, but it is only temporary. The idea of the temporary, reversible death has great affinity with Piaget's stage of general activity. Piaget's and Nagy's first stages have in common the idea of flux, of going, of stopping, and of going again. Maurer (2) affords some insights into the same period when she relates the passion that young children have for the peekaboo game. Children see this game related to the experience of death.

The second stage described by Nagy falls between the 5th and 9th year. During the second stage, death is personified as walking around trying to catch people. Although death has become an irreversible process, it has not become a universal process. It may be useful to remember that the game of tag is a favorite game at this stage (2). As proof for the interwoveness of the concepts, life and death, one must remember that, at Stage 2, the dominant criterion for being alive is the ability to move (Piaget). Death, personified, has become an essentially live being who plays tag with his victims. To link Piaget and Nagy's thinking about this period still closer, one must realize that, at the time of Piaget's investigation, a 7-year-old Swiss child thought a bicycle and a car to be alive, even though a bicycle and a car clearly need human intervention to move. It seems, then, that during Stage 2, life can be brought about externally to an object (riding the bicycle). In complete analogy, Nagy discovered that death is thought of as being brought about externally (death catches *it* and then *it* is dead).

Around the age of 9, the child equates life with movement by itself. Life has become an internal process. Nagy writes that during the third period the child gains awareness of death as an internal process. Therefore *E* characterized the third periods described by Nagy and Piaget as the period when "*it* goes by itself." Nagy's third stage is when the children are in their 9th and 10th years. Children in that stage recognize death as a process that takes place in everyone. In Nagy's third stage, the child's conception of death becomes more realistic, He knows that death is inevitable.

The great similarity in the formulations by Nagy and Piaget served as the theoretical basis upon which this study was based.

B. HYPOTHESES

1. It is hypothesized that, as an individual increases in age, his tendency to attribute animism and death to objects decreases. Specifically, the accuracy of

one's concept of life improves when one moves from Stage 1 to Stage 2 to Stage 3 because the criteria for calling something alive improves. It is contended that the same criteria change the concept of death which concept, therefore, should improve similarly. The rate of improvement for both concepts should be very nearly the same because the criteria are the same.

2. It is hypothesized that a common rationale binds the concepts of life and death during each stage of development.

A common rationale refers to three central ideas that govern the three stages of development with which *E* worked. For Stage 1, the idea of *flux*. Something goes, then it stops, then it goes on again. There is an absence of the idea of absolutes. For Stage 2, the idea of the *outside agent* (externality). Something makes it go, something makes it stop. For Stage 3, the idea of the *internal agent* (internality). Something goes by itself, something stops by itself.

The independent variable is the age of our subjects. By varying the ages from group to group a higher or lower percentage accuracy in the use of the terms "death" and "alive" are achieved. (Accuracy is based on the adult standard norms that imply that only plants and animals can live and die.) Accuracy in the application of the two terms, "death" and "alive," constitutes the dependent variable.

In this study, the test is constructed in such a way that a normal adult would score zero on both the life and death concepts. There is a score for each subject, and for each of the three stages there is a "death" score and a "life" (animism) score. The score is based on inaccuracies in the application of the life and death concepts. The criteria for the "common rationale" are constant flux, externality, and internality.

C. METHOD

1. *Sample*

Three groups of boys, aged 4-5, 7-8, and 10-11 years, were used in this study. There were 10 members in each group. Boys alone were used because a mixed group might have augmented uncontrollable variance. (Both Piaget and Nagy used mixed groups.)

The three groups selected for this study corresponded to the three groups studied by Piaget and by Nagy. All of the boys in the 4-5 age group at the Stanford Nursery School had their names written down on separate cards, which cards were shuffled together in a box, and 10 cards were drawn to constitute the first group. The same procedure was followed to choose the 10 boys for each of the remaining two groups. The nursery school used in the first group is centrally located in San Francisco, it is a nonprofit organization, and it attracts children from a variety of different socioeconomic backgrounds. The second and third groups were obtained from the Ponterosa School in South San Francisco.

2. *Procedure*

For all three groups, the individual administration of the stimulus words was done in school health rooms to avoid possible noises and disturbances. One child at a time was brought into the room and orally presented with 10 stimulus words: dog, ball, tree, bike, boy, moon, mother, ocean, car, cloud. The list of words consisted of the names of six inanimate objects and of four animate objects, the latter being interspersed with the former to force a new decision at each point and to prevent perseveration. The words used were chosen because they had been overheard at the nursery school in children's verbalizations and the objects represented frequently had been drawn by them. Therefore, questions could be asked concerning those particular objects because all of the names validly referred to objects in the child's perception. The short attention span of young children was also considered; so the questions were made as short and simple as possible.

In the first part of the examination, the child was asked the following questions regarding the stimulus word, one word at a time.

Question 1. Does a (S word) live? Is a (S word) living?
Question 2. Does a (S word) hurt when hit?
Question 3. Does a (S word) grow up?
Question 4. Does a (S word) die?

As much as possible, the questions were based on those used by Piaget. He clearly indicates that the level of questions affects the level of response more than any qualitative age change in approaches to problem solving (4). This was taken into consideration in planning the questions for all three age groups. Every subject got one point for every animistic response he made. A child who thought that a ball could grow up—that a ball lives—received two points. After all the questions of the first part of the examination were asked, the child was assigned an animism score. An animism score of 10 means that a subject gave 10 animistic responses to the list of questions presented during the first part of the examination.

The second part of the examination consisted of an interview. *E* looked over the first part and noted the animate (both positive and negative) responses. The interview was to elucidate the second hypothesis regarding the rationale present (at the different stages) for the decisions about life and death. A tape recorder for a verbatim record of the exchanges was used. Example of the questions:

> How can you see that a ball (ball is inanimate object to which the subject had answered yes in a previous part) is alive? How can you see that a ball dies? What happens when a ball dies? How do you know? And then . . .? Why do you say this?

It must be remembered that this part of the questioning was undertaken to establish a rationale, a more absract level, as suggested by both Piaget and Nagy, for the responses of the different age levels.

The "death" score was computed by adding the negative animistic responses (if a subject answered that a ball, the moon, and a cloud could die, he received a "death" score of 3). The type of data obtained from the second part of the examination was difficult to quantify. Categories were constructed by *E*. Two independent judges listened to the tape-recorded conversations and answered the following questions for every subject.

1. Is life or death seen as a recurrent process?
2. Does life or death come from the outside to a person or a thing (external process)? Or does it come from the inside, and is it seen as an internal process?
3. Is there neither basis for considering life or death either as a recurrent or irrevocable or as an internal event?

The five categories were:

> *Flux*. the central idea being that life and death are temporary. Death is not perceived as the irrevocable point beyond which life stops. The idea of flux permits an unlimited number of deaths, interspersed with periods of life.
>
> *Yes and no*. Death is no longer reversible. Death, however, is evitable. One can escape death ultimately. Death is personified in this stage. Death may catch someone or fail to catch someone. Any indication of a personified death trying to catch his victims with the possibility for escape for the victim would come under this category.
>
> *Adult and pseudo-adult*. Death is substantially seen within the adult limitations. Death is permanent. Death is inescapable. The concept of death may be misapplied, however. The idea of an irreversible, inescapable death for a ball or a car fits into this category. Such an idea is termed "pseudo-adult."
>
> *Undecided*. On the basis of the answers the judge does not feel that he is justified in making a decision within the indicated response categories.
>
> *Contaminated*. The judge felt that the interviewer led the child to a particular response; that the response was one not arising spontaneously out of the thinking of the child.

The question of whether or not the subject saw death as a recurrent phenomenon showed in his answer to the question: "and then . . .?" Obviously, when the former activity is taken up again, one is faced with a concept of death that is not absolute. Logically it follows that when death is not absolute (and therefore interspersed with periods of living) life is not absolute either. Insight was gained about the externality or internality of life and death by asking questions, such as "How can you see that a bicycle is alive?"

Each subject received an "animism" score and a "death" score. He was classified in terms of the previously mentioned five categories.

The judges were given instructions (printed) telling them that they would be presented with a taped recording in which certain children were being asked indirectly about their concept of life and death. The judges were informed that the purpose of the study was to test certain hypotheses about the nature of the relationship between the two concepts. For each child, each judge was given a data sheet that had the 10 stimulus words listed in the left-hand column. At the top of the sheet were the five categories. The entire interview with each child was recorded so that the judges could follow the sequence. Also, a judge could replay the tape or portions of it if he had any doubt as to his choice of category. The judge listened to each child's answers and evaluated each stimulus word independently. For example, if in connection with the word "ball," the child responded in a way that made one certain that the child had anthropomorphised (i.e., had ascribed human characteristics to inanimate objects), the judge placed a check mark under category "yes."

D. Results

Table 1 gives the mean scores for the three different age groups. It shows a decrease in "animism" and "death" scores with increase in age. This finding lends suport to the first hypothesis.

Table 2 shows a positive correlation between "animism" and "death" scores for each of the three age groups. This finding seems to support Hypothesis 1. Note that in Group 3 (the oldest group), the positive correlation between the animism and death concepts is high. This seems to indicate a greater integration toward a mature, adult reality. The findings for Group 1 (the youngest group) show that its members tend to see life and death in a global manner. The children at the age of 4 and 5 see everything as alive, but in constant flux (with a lack of differentiation by adult standards). While the concepts of animism and death do relate to each other in the child's approach to the world, his view could be classified as syncretic; he does not see integration in terms of any causality. In Group 1, the children were very consistent in their responses and seem to have an integrated concept of life and death, although not in an adult sense. The concepts animism and death are related. In Group 3, the child's concepts (by adult criteria) become integrated at a higher level. Group 2 shows that the animism and death concepts are not related to each other to such a marked degree as in Groups 1 and 3. One possible explanation is that, according to Piaget's theory, the child at age 7 is going through a transitional phase. He is shifting from a global approach to an analytic approach to reality.

TABLE 1
MEAN SCORE OF DIFFERENT AGE GROUPS TESTED FOR CONCEPTS OF ANIMISM AND DEATH
($N = 60$)*

Concept	Group 1 (age 4-5)	Group 2 (age 7-8)	Group 3 (age 10-11)
Animism	14.6	2.7	1.4
Death	3.9	.6	.3

* $N = 2$ responses for each subject, with 10 subjects in each group.

TABLE 2
CORRELATIONS OF ANIMISM AND DEATH FOR THREE AGE GROUPS OF CHILDREN

Concept	Group 1 (age 4-5)	Group 2 (age 7-8)	Group 3 (age 10-11)
Animism and death	+.67**	+.44*	+.87**

* Significant at the .05 level.
** Significant at the .01 level.

Table 3 shows the results of an analysis of variance. The *F* ratio is 52.2, significant beyond .01 level.

The data in Table 4 lend support to Hypothesis 2 concerning a common rationale.

Table 4 shows the mean number of responses falling into the three common rationale categories. The cell numbers representing mean scores were obtained by having two independent judges categorize the responses for the age groups.

Along with the idea of integration, would be a transition from the ideas of flux to the adult concept. For example, the child in the first stage does not recognize any definite limits between his self and the external world. He considers inert objects as living (Piaget). Nagy's first stage parallels this in that the child sees life in death and vice versa. There seems to be support of the idea that three central ideas govern the three stages of development: constant flux, externality, and internality. Group 1 displays clear evidence of thinking about life and death in terms of flux. Some examples: "A ball is living when it goes up in the air and when the ball goes down, it dies dead." "The moon dies when it's blown up, but it comes back to life the next day." Statements made by the children showing how they see death as something temporary and reversible were: "The ball dies when the air is let out, but when you blow it up again, it lives." "The moon is dead today, but at night it lives."

Group 2 shows most of the children in the yes and no category. There is the idea of the outside agent. The findings support Piaget's theory that anything that moves is alive. An example: "A bike is living because it's moving." Nagy's findings of how a child at this stage personifies death is indicated in Table 4. There seems to be evidence to indicate the developmental trend in the conceptualization of death and life so far. "It dies when it goes up in the air" (moon). "A boy dies when he's bad and God makes him die." These are examples of the idea of externality.

TABLE 3

ANALYSIS OF VARIANCE FOR ANIMISM AND DEATH SCORES FOR THREE DIFFERENT AGE GROUPS

Source	*df*	*MS*	*F*
Between	5	292.056	52.2**
Within	54	5.598	

** Significant at the .01 level.

TABLE 4

MEAN NUMBER OF RESPONSES FALLING INTO JUDGMENT CATEGORIES ($N = 30$)

Group	Flux	Yes and no	Pseudo-adult and adult	Undecided	Contaminated
Age 4- 5	.9	.1	0	0	0
Age 7- 8	.2	.7	.1	.1	0
Age 10-11	0	.2	.8	0	0

Group 3 has none of the children in the flux category. Some examples of responses judged to be in the yes and no category: "The moon dies when it's hit by a rocket." "The ocean dies when all the fish die." Some examples of the adult and pseudo-adult responses: "A cloud dies when it rains." "You die because that's the end of life." Group 3 shows the idea of internality to a certain extent. Piaget's theory for Stage 3 is that the child considers as alive anything that can move by itself. Nagy's theory for Stage 3 is that death is seen as a process that happens to one according to certain laws. Therefore, Piaget and Nagy's theory of definite modal-development stages in the child's thinking about life and death seems to be supported.

E. Discussion

The primary purpose of this study was to determine if a relationship exists between life- and death-concept formations in children, by observing certain measurable changes in one concept as these changes parallel the measurable changes in the other. The study was concerned with the possibility of a relationship between the two concepts.

The boys in Group 1 were spontaneous in their responses. They did not question whether things were alive or dead. They did not ask any questions. This supports Piaget's findings that the animism of young children (4-5 years) is implicit and unformulated. The boys in Group 1 appeared to show an animism that was both integral and implicit. They seemed to regard occurrences as intentional. For example, they gave responses, such as "The tree hit me." "The bike dies when the wheel falls off.'" Anything that moves is described as if it were conscious and every event as if it were purposive (Piaget). Group 1 showed great fluidity in their responses. Also, the boys did not have a generic sense of dog, bicycle, or ball. If they didn't have one, they answered, "I don't know, I don't have one." Group 1, generally speaking, saw death as temporary, reversible, and as a departure. An example: "When the car goes away, it dies dead." This supports Nagy's findings of the death-concept formation in young children.

Piaget's second stage, the analytic (around age 7), seemed to be apparent in Group 2. The boys expressed fear of the questions because they were afraid it was a "test." They asked repeatedly whether or not the answers would go on their record, would they get grades, etc. They took several minutes before answering the questions. They seemed to be reflective. They asked many questions, especiallly about death. Their answers showed an interest in scientific explanation. One boy's interpretation of a cloud growing up was, "A lot of vapor rises into clouds, forms a sort of living ocean in the sky, so then it rains and empties itself dry." "Scientific study" was the answer given by several boys when asked how they knew the cloud grew up, etc. One reference was made to authority by one boy. For example: "I know that because my mother told me." "The teacher says so." Thus the precise feelings and reasonings behind his answers may have become obscured. Several boys in Group 2 talked about death, "terrors," and "wars." "We shouldn't think about things like war heads, atomic wars, and people being killed overseas." Piaget writes that children at about age 7 are concerned with death in their attempts to find a definition in life. Examples of how the boys saw death as being externally caused and personified, and examples which lend support to

Nagy's findings are: "The black angel carries you off and then you die." "God makes you die."

The boys in Group 3 seemed to be moving toward synthesizing the concepts of life and death, for they become more integrated at a higher level, by adult criteria. The reality principle comes into play. Egocentricity is expanded to sociocentricity. One must remember that Piaget worked with Swiss children in the late 1920s, and Nagy worked with Hungarian children in the 1940s. As a differentiator between those times and now, one must look to television, which most children watch for various lengths of time today. They have more accidental and violent deaths within their field of vision than any previous generation: for example, in Westerns, in mystery stories, in cartoons, etc. The greater awareness of death (in this decade with its threat of atomic annihilation) may have brought about an earlier sophistication in this area for some of the children. Many references to television were made by the boys in Group 3.

By testing the hypotheses through two different and independent techniques, the reliability of the results may have been improved. The independent judges were introduced to improve the reliability of the findings for Hypothesis 2. Factors that were not controlled and that could have influenced results are socioeconomic background, *IQ*, religion, ethnic background, and educational level of the parents, and of the child.

Hypothesis 1 alludes to a correlation between two distinct phenomena, but it does not investigate the nature of the relationship. Hypothesis 2 seeks to establish a common rationale that would augment validity. The results lend support to the idea that there is some consistency in response between "animism" and "death." The next step in research is to determine the relation of the various aspects of "animism" and "death" to behavior. An area of further research might be to determine the practical applicability of a child's life and death concepts.

F. SUMMARY

The primary purpose of this study was to determine whether or not an individual's "animism" score and his "death" score decreases as he gets older. The secondary purpose was to determine if a common rationale bind the concepts of life and death during each stage of development.

The sample population consisted of three groups of boys (10 in each group). Age was the independent variable. Groups 1, 2, and 3 respectively were 4-5, 7-8, and 10-11 years old. An "animism" test of 10 stimulus words was verbally administered individually to each child. The test questions were modeled after Piaget's questions. Each subject was given a positive "animism" (life) score and a negative (death) score. The second part of the test was an interview to determine the subject's reasoning behind inaccurate responses he had made in the first part of the test. Answers were sought that would establish or deny a common rationale.

The mean scores show a decrease in animism with an increase in age. Correlations between "life" and "death" responses reveal a positive correlation for each age group. There appears to be a gap in the trend in Group 2. An interpretation of this finding is that the age of 7 is the beginning of an analytic period for the child (Piaget). The *F* ratio obtained was 52.2, significant beyond the .01 level. Two judges independently listened to a taped recording of the second part of the test. They judged the responses and placed them into one of five categories that had been established by *E*. The judges' conclusions seemed to support a common rationale underlying Piaget's stages of animism and Nagy's stages of death conception.

The study shows that there is a positive relationship between life- and death-concept formation. The stages are parallel in their development. The concepts per se were not investigated.

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AUTONOMIC FUNCTION IN THE NEONATE: VI. DISCRIMINABILITY, CONSISTENCY, AND SLOPE AS MEASURES OF AN INDIVIDUAL'S CARDIAC RESPONSIVITY*[1]

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A. INTRODUCTION

This study represents a continuation of attempts by the authors to obtain measures of aspects of autonomic functioning that characterize the individual infant subject.

The patterned cardiac-rate response of a newborn infant to a standard 5-second air-stream stimulus was fully described in a previous report (see Figure 1). This consisted, in general, of two phases: the first in which the heart rate reveals an increasing departure from the prestimulation heart rate and, in time, reaches a peak departure; this is then followed by a decreasing departure or a return in heart rate toward the initial level. We also presented an analytic method that consisted of extracting estimates of clearly defined parameters from each response. When recombined, the estimates essentially would reproduce the original response curve (7, 8).

These parameters, in general, are of two types: those representing magnitude scores (peak-, primary slope-, return-, and secondary slope-magnitude scores) and those constituting time measurements (peak-, primary slope-, return-, and secondary slope-time measurements). Such a categorization is also based upon the finding that the magnitude parameters are linearly related to the log of the prestimulus heart rate [the "law of initial values" (13)], whereas the time parameters are relatively independent of the "state" of the cardiac system at the time of stimulation. As a result, it is possible to extract two measures or indices—mean and standard deviation—for each of the time parameters. Subsequent analyses revealed that differences between neonates occur for both the average timing of each component of the response curve as well as the consistency of the time values.

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The extraction of indices for the magnitude parameters did not prove as straightforward. This was complicated by the fact that there is no single measure that can be used to represent the "average" response. In reality there are many "average" responses, depending upon the prestimulus level chosen. Responses of greatest magnitude occur at lower levels of prestimulus heart rate.

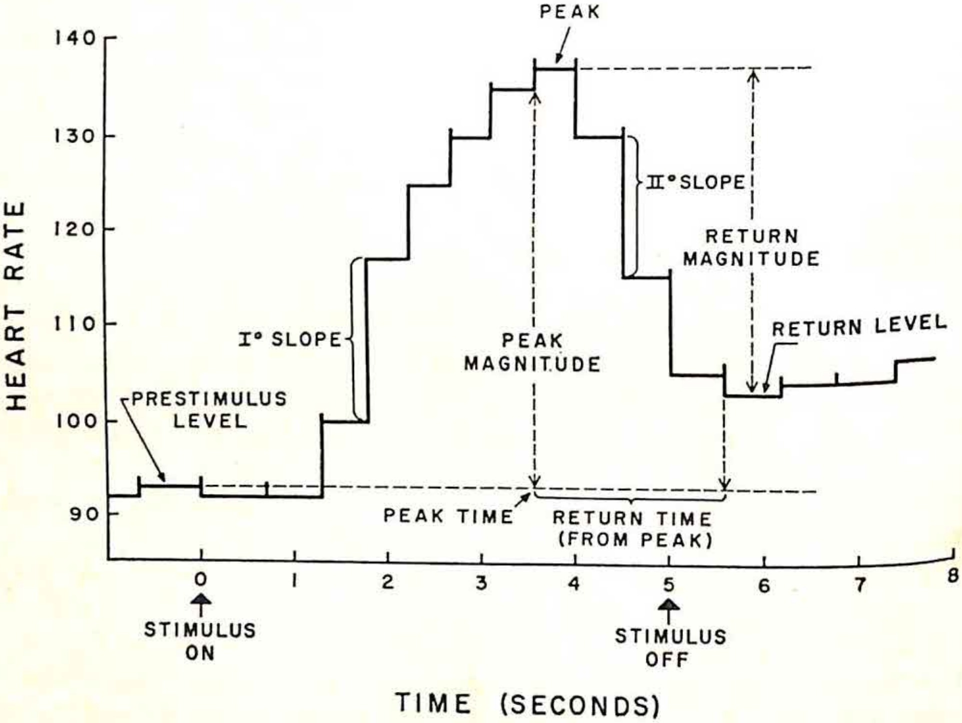

FIGURE 1

Schematic Representation of a Cardio-Tachometer Record, Illustrating the Cardiac Response to an Air-Stream Stimulus as well as the Obtained Response Measures

One of the problems, then, concerned the choice of an appropriate prestimulus heart rate. This was resolved by inquiring into the maximal reactive capacity (average maximal reactivity) of the individual, considering each of the magnitude parameters separately. The measure of maximal reactivity was thus defined as the expected value at the lowest prestimulus heart rate achieved by the individual. It was also suggested (on theoretical grounds) that states of minimal physiologic activity were more directly comparable in considering differences between individuals. Consequently, a regression model was employed and four measures of maximal reactivity were obtained for each individual; one for each of the magnitude parameters. Further examination revealed this measure to be an effective means for comparing individuals. However, fundamental to the validity of this measure is the assumption that the minimum prestimulus heart rate can be defined for each individual. The authors have some evidence for reproducibility of this latter measure within a subject.

Recognizing this limitation to the concept of maximal reactivity, we have continued to search for additional means of describing the individuals' response characteristics when considering the magnitude parameters separately.

It is the purpose of this report to present the results of study of three response measures not previously considered: (*a*) slope of the regression of response magnitude given prestimulus heart rate (b_{yx}), (*b*) the standard error of estimate around this regression line (S_{yx}), and (*c*) the discriminability ratio—a derivative of the two preceding measures.

B. RESPONSE MEASURES

It is self-evident, without implying a causal relationship, that greater slopes represent greater "effects" of prestimulus heart rate on the average response. Furthermore, the measure of variability (S_{yx}) represents the degree of response consistency within a most variable biological system.

The discriminability ratio evolved initially from a consideration of the possible application of certain perceptual concepts to the present situation. The area of psychological perception is replete with discussions of, and data relevant to, the ability of an organism to respond differently to inputs of different magnitudes. In line with this discussion is the concept of the difference threshold, which is the smallest difference between stimuli noted to be perceptually different. One method of determining this threshold is to present two stimuli differing by some measurable amount and asking the system (in this case the individual) to report on which of the two is greater (or lesser). By varying the actual amount of difference between the two stimuli, one can determine the smallest difference necessary to achieve a stated percentage of greater responses for a given type of input.

Although there are marked differences between the perceptual paradigm and the present situation, it was felt that a concept of discrimination thresholds or discriminability might still prove fruitful. One major difference between the two situations concerns the constancy of the stimulus input: In the perceptual schema, the external stimulus is varied and all other conditions are held constant; whereas the present data were obtained when the external stimulus was constant and the physiological state (i.e., prestimulus heart rate) was permitted to vary. Nonetheless, one characteristic of the cardiac-responsivity system is the extent to which it responds differently with incremental changes in prestimulus heart rates. In essence, then, we are asking how different must two prestimulus rates be before we can detect a statistically significant difference between responses at the two levels: the smaller the difference, the greater the discriminability.

An example might facilitate an understanding of the concept of discriminability as well as demonstrate, in gross fashion, the two fundamental components of its determination. Figure 2 presents the obtained linear relationship of peak-magnitude scores (Y) as a function of the log-prestimulus heart rate (X) for a given subject. It should be kept in mind that the solid line represents the *mean* Y scores to be expected for different X scores.

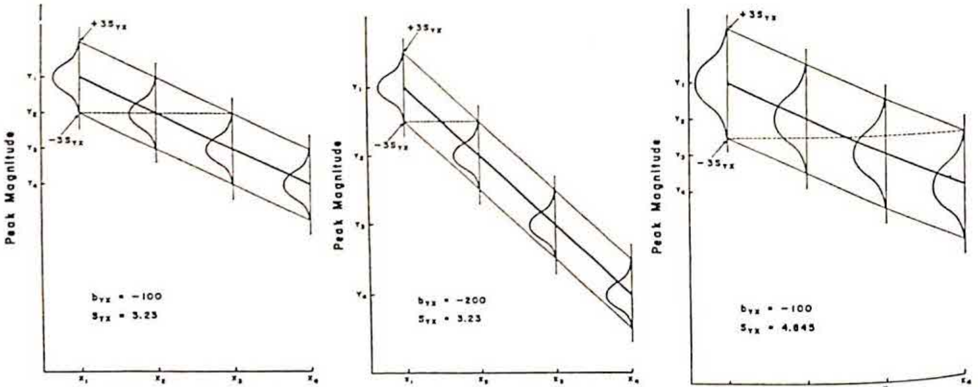

FIGURE 2
GEOMETRIC DETERMINATION OF DISCRIMINABILITY AS A FUNCTION OF CHANGES IN b_{yx} AND S_{yx}

Let us assume that we can arbitrarily prefix any given prestimulus heart rate and repeatedly test at that level. We can then expect to obtain various peak-magnitude scores that assume a normal distribution around the mean for that level. Following this procedure, at four equidistant log-prestimulus heart rates, we then have the situation as depicted in Figure 2A. In this example, let us assume that the total distribution of Y scores at a given log-prestimulus heart rate is contained within the mean of Y plus and minus three standard deviations. To determine the discriminability for this system, we must determine the inverse of the smallest difference between the X scores the Y distributions of which overlap at some stated level. For the sake of simplicity, let us select zero degree of overlap of the two distributions as our defining criteria. Using the distribution X_1 as an anchor point, we can then extend a horizontal line from $Y_1 - 3SD$ until we arrive at the first X score whose Y distribution has zero overlap with our anchor distribution. It can be seen that this is achieved at X_3; therefore the degree of discriminability is equal to the inverse of the difference between X_3 and X_1.

The representation in Figure 2B differs from that in Figure 2A in that the former has a greater slope: the standard deviations and selected prestimulus heart rates are the same. Employing the same rationale as previously it will be seen that the discriminability measure is now equal to the inverse of the difference between X_2 and X_1. There is thus greater discriminability in this situation than in that depicted in Figure 2A.

The third figure, 2C, has the same slope as that in 2A, but differs in having a greater standard deviation. Discriminability is then the inverse of the difference $X_4 - X_1$, and indicates a poorer level of discriminability.

In summary, then, the discriminability of a system is a direct function of the slope of the line and inversely proportional to the standard deviation. Thus the discriminability is a function of the ratio $b_{yx} \div S_{yx}$. A more rigorous determination of an appropriate measure of discriminability is presented in the Appendix.

C. Subjects and Experimental Method

A total of 16 healthy female infants, two to five days of age, were employed in this study. These are the same infants on whom data have previously been presented (7, 8). All subjects were tested postfeeding during two to four sessions; each session lasting approximately two hours. During each session the subject was repeatedly stimulated with an air stream of five-seconds duration delivered to the abdominal area immediately above the umbilicus. Continuous cardiac activity was obtained by means of a cardiotachometer before, during, and after stimulation. The attempt was made to present the air-stream stimulus at that point in time when the cardiac rate was relatively stable. Greater detail concerning the testing procedure and laboratory techniques can be found in the earlier reports.

D. Results

1. *Slope of the Regression Line* (b_{yx})

Comparisons of the slopes within each of the four magnitude parameters reveals marked differences between newborns. These obtained slopes (b_{yx}) are presented graphically in Figure 3. Examination of the subfigures indicates that individual values range from −19 to −109 for Primary Slope, from

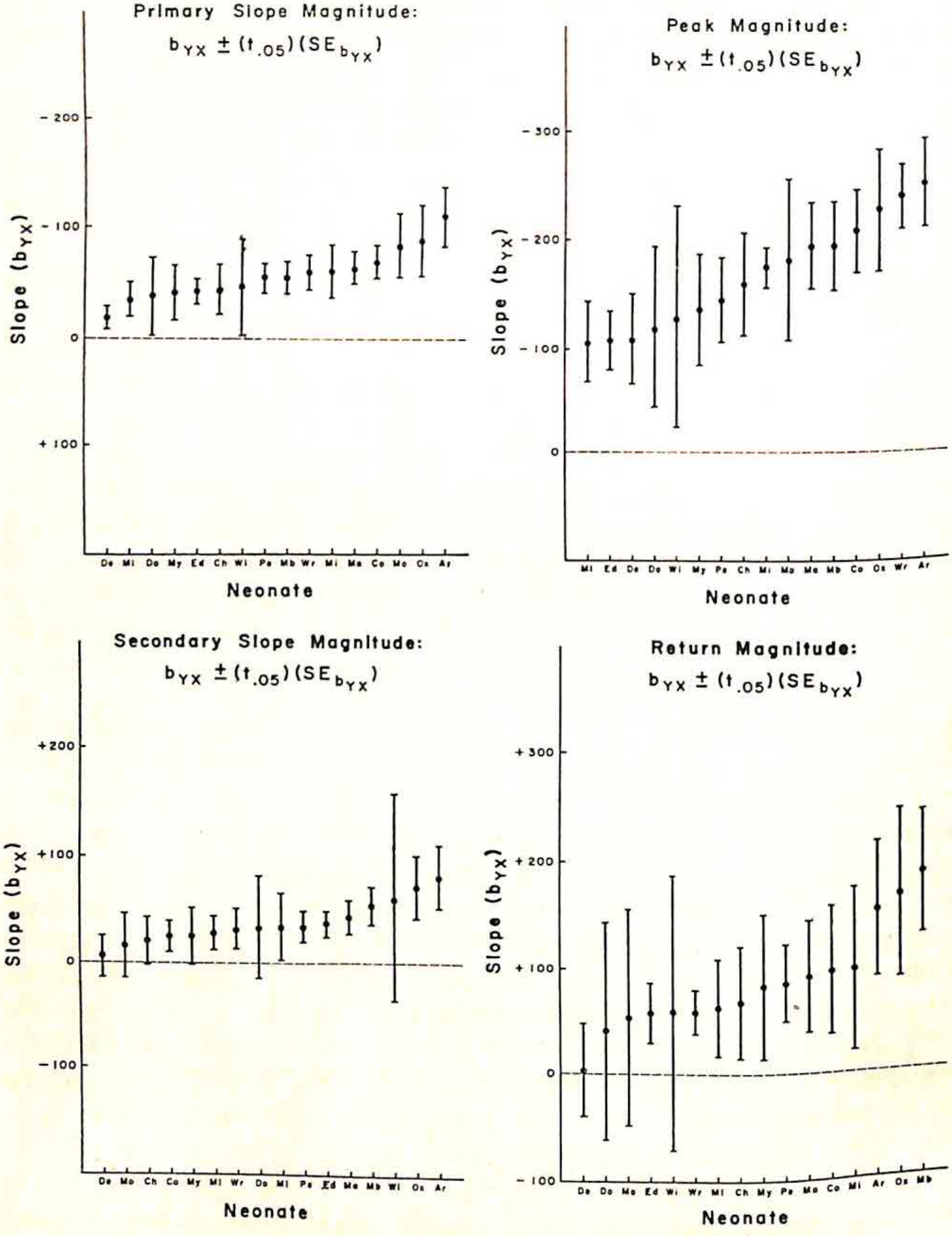

FIGURE 3
ESTIMATED SLOPE OF THE REGRESSION LINE (b_{yx}) AND THE 95 PER CENT CONFIDENCE INTERVAL FOR THE MAGNITUDE PARAMETERS IN EACH OF 16 SUBJECTS

—106 to —253 for Peak, from 7 to 82 for Secondary Slope, and from 3 to 188 for Return. These figures contain, in addition to the b_{yx}, the appropriate 95 per cent confidence interval.

Because it was one of our original interests to determine whether or not there were statistically significant differences between subjects, some overall test of significance would have been desirable. Such an analysis, however, was not possible. Instead, this evaluation was based upon an examination of confidence intervals.

The statistical significance between any two individuals can be determined (grossly) by visually considering whether the confidence interval of one individual contains within it the b_{yx} of the other individual. In those instances in which the b_{yx} was just outside the confidence interval, a more rigorous test was employed utilizing the standard error of the difference between slopes. Such a procedure, admittedly not exact, is both time saving and adequate for our present purposes. Consider Figure 3A (Primary Slope) as an example. Examination of this figure reveals that all of the b_{yx}'s equal to or greater than *Pe.* fall outside the confidence interval of baby *De.,* and vice versa. Consequently, it can be concluded that the former group of babies probably differs significantly ($p < .05$) from *De.* Careful consideration of each of the figures indicates that significant differences do exist between infants for each of the four magnitude parameters.

By virtue of the inherent characteristics of the magnitude parameters, it is to be expected that the slope of the regression line for Peak Magnitude will be greater than that for Primary Slope, and that the slope for Return Magnitude will be greater than that for Secondary Slope. This expectation derives from the fact that, for each of the trials (except those in which there is no cardiac response to stimulation), the *absolute* value of Peak Magnitude and Return Magnitude is greater than their respective Slope Magnitudes. This expectation turns out to be the case. There are, however, two individuals, *Wi.* and *De.,* who demonstrate a reversal from the expected direction when Return Magnitude and Secondary Slope are compared. This observation becomes understandable when it is recognized that in each case the two slopes are not significantly different from zero. No reversals occurred in any infants for the other pair of magnitude scores.

There is, however, nothing inherent in the definition of these parameters that fixes the relationship between the absolute slope values of Peak Magnitude *vs.* Return Magnitude and that between Primary Slope *vs.* Secondary Slope. Therefore, it is of interest that each baby has a greater absolute slope for Peak Magnitude than for Return Magnitude. Furthermore, Primary

Slope has a greater absolute value when compared to Secondary Slope in all babies but one (*Wi.*). A two-tailed Wilcoxon matched-pairs signed-ranks test applied to these data yields, in both cases, a *p* value less than 0.01 (11).

2. *Standard Error of Estimate* (S_{yx})

Table 1 contains an estimate of the variability of response scores around the regression line for each individual and magnitude parameter. Examination of this table reveals apparent differences between individuals. To test rigorously for the statistical significance of these differences between individuals, Bartlett's test for homogeneity of variance was employed [see Edwards (4)]. This test was conducted separately for each of the magnitude parameters. The results of these analyses were clear in that each of the four chi-square values was greater than 93 ($df = 15$, $p < .01$); thus it seems safe to conclude that there are statistically significant differences in the response variability of neonates.

TABLE 1
STANDARD ERROR OF ESTIMATE (S_{yx}) FOR EACH SUBJECT AND MAGNITUDE PARAMETER

Subject	N	Primary Slope	Peak	Secondary Slope	Return
Ar	56	3.87	6.16	4.40	9.32
Ch	51	4.42	9.22	4.43	10.47
Co	61	2.61	6.57	2.72	10.56
De	70	1.76	7.22	3.28	7.17
Do	41	5.11	11.05	7.12	15.10
Ed	73	3.60	8.64	3.90	8.93
Ma	93	3.81	10.38	4.29	14.23
Mb	82	3.27	9.72	4.31	13.70
Mi	47	4.74	9.34	6.18	15.22
Ml	58	4.56	11.29	4.79	13.61
Mo	61	4.06	10.70	4.44	14.74
My	35	4.06	8.53	4.52	11.41
Ox	46	7.78	13.97	7.30	19.51
Pe	41	3.76	10.77	4.00	10.10
Wi	24	3.11	7.47	7.02	9.39
Wr	54	2.71	5.35	3.35	11.49

* Presented, also, in (10).

Further examination of Table 1 reveals that Primary Slope, in all but one instance (*Ox.*), is associated with the smallest variability. The greatest variability is noted with Return Magnitude. Peak Magnitude and Secondary Slope have intermediate values, with Peak Magnitude having the greater variability of the two. Thus, the ranking in order of *increasing* absolute variability is Primary Slope, Secondary Slope, Peak Magnitude, Return Magnitude. To test the overall statistical significance of these data, use was made of the Friedman two-way analysis of variance by ranks (11). This resulted in a chi square of 44.8 ($df = 3$, $p < .01$). A Wilcoxon matched-pairs signed-ranks test was then employed between each pair of parameters to determine the probable source of this significance. In all comparisons, a $p < .01$ was obtained. It should be pointed out that the parameters with the greatest absolute variability, Peak and Return Magnitude, are also associated with the largest absolute mean-response values.

TABLE 2
Coefficient of Variation [$100\ S_{yx} \div \bar{y}$] for Each Subject and Magnitude Parameter

Subject	N	Primary Slope	Peak	Secondary Slope	Return
Ar	56	78.81	69.69	92.28	135.92
Ch	51	154.40	109.86	159.11	184.76
Co	61	70.45	55.35	93.74	113.01
De	70	49.48	53.71	70.21	71.29
Do	41	235.40	131.85	185.94	197.17
Ed	73	106.40	86.52	113.43	120.05
Ma	93	77.36	71.03	94.41	100.71
Mb	82	97.94	74.67	99.00	103.06
Mi	47	45.23	33.38	77.25	62.75
Ml	58	67.30	69.44	97.48	108.88
Mo	61	85.40	61.69	106.63	114.98
My	35	72.13	51.65	77.55	78.92
Ox	46	135.56	69.55	83.95	87.22
Pe	41	40.62	46.87	60.73	65.11
Wi	24	79.40	72.88	79.47	69.77
Wr	54	41.81	25.54	56.53	72.31

Thus far we have compared variability solely in terms of its absolute values. However, by virtue of the simultaneous changes in both the mean response as well as its variability it is also of value to consider the *relative* degree of variation for each parameter. One such measure is the coefficient of variation (12). Consequently each S_{yx} was divided by its appropriate mean response and, to convert it to a percentage, multiplied by 100. Table 2 contains the coefficient of variation for each subject and magnitude parameter. When viewed in this manner, it can be seen that there is still a great deal of response variability associated with each of the parameters: the lowest obtained coefficient of variation is 25.54 per cent and, in many instances, is greater than 100 per cent. Furthermore, in order of increasing relative variability, the ranking is Peak Magnitude, Primary Slope, Secondary Slope, and Return Magnitude. A Friedman two-way analysis of variance by ranks resulted in a chi square of 30.9 ($df = 3$; $p < .01$) and individual Wilcoxon (two-tailed) tests between pairs of parameters were all significant ($p < .05$), except that between Primary and Secondary Slopes.

The major change in the rank order of parameters occurs for Peak Magnitude. Whereas it demonstrates more *absolute* variability than Primary and Secondary Slopes, it has the smallest *relative* variability.

3. *Discriminability Ratio* ($b_{yx} \div S_{yx}$)

Thus far it appears clear that individual differences are manifest when considering the components (S_{yx} and b_{yx}) of the discriminability ratio. However, prior to any meaningful pursuit into the value of the discriminability ratio, it is also necessary to demonstrate the relative independence of S_{yx} and b_{yx}. Consequently, a Spearman rank-difference correlation coefficient was obtained for each of the magnitude parameters. These were 0.0772, —0.2676, 0.3029 and 0.3029 for Primary Slope, Peak Magnitude, Secondary Slope, and Return Magnitude respectively. None of these values are statistically significant.

The individual discriminability ratios are presented in Figure 4, in which figure each subfigure represents a different magnitude parameter. It should be recalled that the greater the ratio, the greater are the changes in response magnitude associated with slight changes in prestimulus heart rate. Consequently, when considering Primary Slope, Baby *Ar.* shows the greatest degree of discriminability (28.27), whereas Baby *Do.* demonstrates the least (7.47). The range of ratios for the other parameters are 9.37 to 44.95 for Peak Magnitude, 2.10 to 18.69 for Secondary Slope, and 0.41 to 16.68 for Return Magnitude.

The procedure used for determining the statistical significance of individual b_{yx} scores was also employed for the discriminability ratio. Careful examination of Figure 4 clearly demonstrates that gross differences ($p < .05$) between individuals do exist for each of the magnitude parameters.

Comparisons of the four ratios within individuals reveals that, in general, the greatest discriminability occurs with Peak Magnitude. The remaining ratios, in order of decreasing discriminability, are Primary Slope, Secondary Slope and Return Magnitude. The Friedman test resulted in a chi square of 42.3 ($df = 3$; $p < .01$) indicating, once again, consistent differences between parameters. To explore the source of this significance, two-tailed Wilcoxon tests were run between each pair of parameters. In every comparison, a statistically significant difference was obtained ($p < .05$).

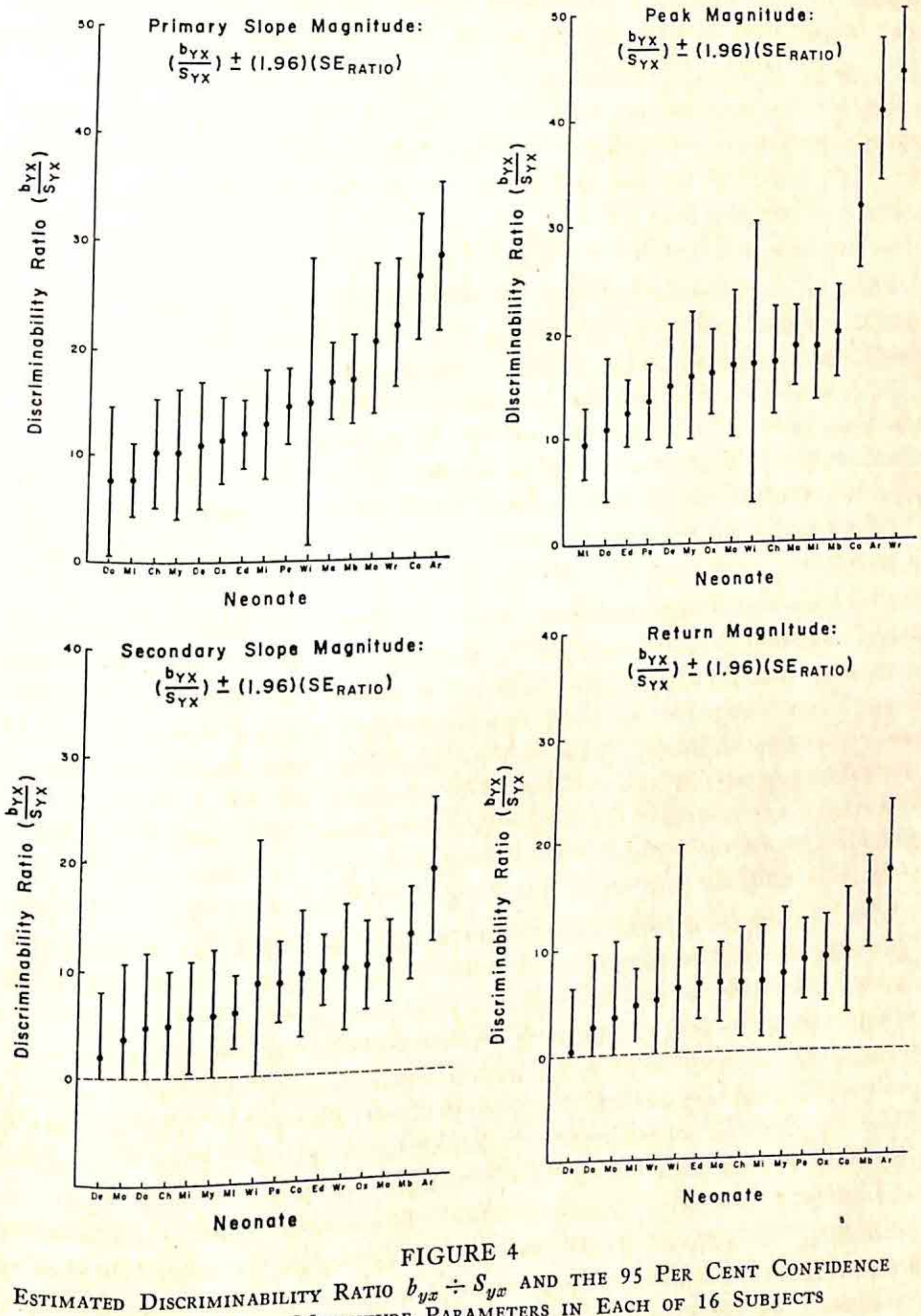

FIGURE 4

Estimated Discriminability Ratio $b_{yx} \div S_{yx}$ and the 95 Per Cent Confidence Interval for the Magnitude Parameters in Each of 16 Subjects

E. Discussion

It is enticing to believe that, by means of an air-stream stimulus, we can evaluate or determine some of the more general characteristics of an individual's cardiac responsivity system. This does not represent an established fact, but a working hypothesis. In employing such a concept we imply that there is a body of transformations, be they inborn or learned, intervening between a stimulus input and the final cardiac response. Furthermore, the exact nature of these transformations in part, is individually determined. The system that is considered obviously includes central and autonomic nervous systems, cardiac and somatic musculature, and pulmonary and vascular components.

The use of an air-stream as a stimulus is but one means of setting the cardiac responsivity system into action and determining its transformation characteristics. Theoretically, other stimuli (i.e., light, sound) should be able to serve the same purpose. At present, it is not possible to go beyond the stage of conjecture concerning the value or generality of the concept. The requirement is for a study in which the same individuals are tested under several stimulus conditions both within the same stimulus modality and across different stimulus modalities. This will permit the determination of characteristics, if any, that apply to varied *input* situations. A preliminary study of intraindividual responses to light, sound, and air-stream stimulation and another study of responses to varying sound intensities are currently in the process of analysis. If these approaches prove fruitful, one can further inquire into the generality of these characteristics for different *response* systems (i.e., respiration, motor, etc.).

In this and the preceding report, we have explored six measures that appear to have potential value within our conceptual model (8). Two of these apply solely to the time parameters: the average and the variability of time response. The remaining four deal with the magnitude parameters within the confines of the applicability of the law of initial values. These latter include maximal reactivity ($Y_{x\text{ min.}}$), response consistency (S_{yx}), "effectiveness" of prestimulus heart rate (b_{yx}), and discriminability ($b_{yx} \div S_{yx}$). Another, the response predicted at the mean of the prestimulus heart rate, appears useful in intraindividual comparisons.

The use of the standard error of estimate and slope of the regression was suggested recently by Bridger and Reiser (3). Within the framework of their experimental situation and analytic procedures, the standard error of estimate and the slope of the regression line were recommended as possible indices of homeostatic efficiency. Although the applicability of the concept of homeostasis is an intriguing one, it does not appear to be completely appropriate to these measures as they are employed.

In exploring the utility of the homeostatic model, we are employing two approaches. One of these consists of the determination of those aspects of the prestimulus and primary response that influence the character of the secondary or return phase of the response. The second procedure requires the extraction (from each individual response trial) of a homeostatic measure that has been termed "prestimulus departure." This represents the extent to which the heart rate returns to its prestimulus level. The homeostatic aspects of the cardiac response to stimulation is discussed more fully in another report (10).

In addition to being measures of different aspects of the cardiac response, S_{yx} and b_{yx} are also free of the criticism involved in the concept of maximal reactivity. Their definition is independent of the choice of any specific prestimulus heart rate. Consequently, they circumvent the need to equate "states" when comparing individuals or conditions. There is, however, an assumption that is being made in the derivation of b_{yx}. As presently obtained, we have assumed that a unit change in log-prestimulus heart rate is equivalent for all babies (8). An alternative approach would be mathematically to transform the log-prestimulus heart rates so that each infant's range equals unity. Infants would then be equilibrated on the basis of prestimulus range and new slopes would be derived. The obvious difficulty with this procedure is in obtaining a valid estimate of the total range of prestimulus heart rates for each subject. Until evidence is obtained to the contrary, we have decided to employ the slope as originally determined.

Previously, the concept of discriminability was discussed in the context of discrimination thresholds. In searching the literature, it was rewarding to note that a similar determination is of value in the area of bioassay (1, 2, 5, 6). Several authors have recommended that the ratio $S \div b$ be used as an estimate of the precision or sensitivity of an indicator system and consequently be employed in the comparison of assay techniques. Gaddum (in 1953), accepting the value of the $S \div b$ ratio, suggested that the reciprocal of this ratio would be a more convenient index of precision because its sampling distribution tends to approach normality when the number of responses becomes large (6). It is not our intent to discuss the relative merits of one or the other ratio, but merely to point out another conceptional schema within which this measure can be considered.

F. SUMMARY

The present study represents an initial evaluation of three additional measures of an individual neonate's cardiac responsivity. These measures relate solely to magnitude responses and are (*a*) slope of the regression of response magnitude on log-prestimulus heart rate (b_{yx}), (*b*) consistency of response (S_{yx}), and (*c*) discriminability or precision $b_{yx} \div S_{yx}$. This evaluation is based on the cardiac rate responses of 16 newborn infants to a standard five-second air-stream stimulus.

Differences between neonates are demonstrated for each of the three measures as obtained for each of the four magnitude parameters (Primary Slope-, Peak-, Secondary Slope-, and Return-Magnitude scores). Furthermore, statistically significant differences are noted when group comparisons are made of the various magnitude parameters; i.e., Peak Magnitude reveals the largest absolute slope, the least relative variation around the regression line, and the greatest discriminability.

These response measures are discussed within the conceptual framework of a cardiac-responsivity system.

APPENDIX[3]

Let the heavy solid line in Figure 2A represent the true regression of response magnitude Y_i on prestimulus heart rate X_i:

$$\hat{Y}_i = A_{yx} + B_{yx}X_i,$$

where A_{yx} and B_{yx} are the true Y-intercept and slope respectively, and $\hat{Y}_i$ the true mean response magnitude.

For each X_i, Y_i is normally distributed around $\hat{Y}_i$ with constant variance σ^2 (true variance).

Let: Y_1 be normally distributed around $A_{yx} + B_{yx}X_1$ with variance σ^2 and Y_2 be normally distributed around $A_{yx} + B_{yx}X_2$ with variance σ^2.

Since we are concerned with the difference between response scores, then $Y_1 - Y_2$ is normally distributed around $B_{yx}(X_1 - X_2)$ with variance $2\sigma^2$.

So: $\dfrac{(Y_1 - Y_2) - B_{yx}(X_1 - X_2)}{\sigma\sqrt{2}}$ is normally distributed with mean zero and variance 1.

Hence: $P(Y_1 - Y_2 > 0)$

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[3] Prepared by Dr. Jerome Blackman, Department of Mathematics, Syracuse University, Syracuse, New York.

$$= P\left[\frac{(Y_1 - Y_2) - B_{yx}(X_1 - X_2)}{\sigma\sqrt{2}} > \frac{-B_{yx}(X_1 - X_2)}{\sigma\sqrt{2}}\right] = \delta.$$

If $K\delta$ is any given percentage point of the normal distribution, then:

$$K\delta = \frac{B_{yx}(X_1 - X_2)}{\sigma\sqrt{2}}$$

or:

$$X_1 - X_2 = \sqrt{2}\, K\delta \frac{\sigma_{yx}}{B_{yx}}$$

Since: 1) $\sqrt{2}\, K\delta$ is a constant for any given situation and
2) the smaller the difference between X_1 and X_2 the greater the discriminability,

then: B_{yx}/σ_{yx} is defined as the discriminability ratio.

Let b_{yx} be the slope as estimated by the method of least squares, $\overline{Y}_i$ the mean response magnitude as estimated from the obtained regression line, and

$$S^2_{yx} = \frac{\sum_1^n (Y_i - \overline{Y}_i)^2}{n - 2}$$

then: $\left[\frac{b_{yx} - B_{yx}}{\sigma_{yx}}\right] \sqrt{\Sigma(X_i - \overline{X})^2}$ is normally distributed with mean zero and variance 1,

$$\text{or: } \frac{b_{yx}}{\sigma_{yx}} \sqrt{\Sigma(X_i - \overline{X})^2} = \left[\frac{b_{yx} - B_{yx}}{\sigma_{yx}}\right]\sqrt{\Sigma(X_i - \overline{X})^2} + \frac{B_{yx}}{\sigma_{yx}} \sqrt{\Sigma(X_i - \overline{X})^2}$$

is normally distributed with mean $[B_{yx}/\sigma_{yx}] \sqrt{\Sigma(X_i - \overline{X})^2}$ and variance 1.

Since: $(n - 2)\ S^2_{yx}/\sigma^2_{yx}$ has a χ^2 distribution with $n - 2$ degrees of freedom.

Therefore:

$$\frac{\frac{b_{yx}}{\sigma_{yx}}\sqrt{\Sigma(X_i - \overline{X})^2}}{(n - 2)\,\frac{S^2_{yx}}{\sigma^2_{yx}}} = \frac{b_{yx}}{S_{yx}} \sqrt{\Sigma(X_i - \overline{X})^2}$$

has a noncentral t distribution.

For large n this distribution approaches the normal distribution with mean $[B_{yx}/\sigma_{yx}]\sqrt{\Sigma(X_i-\overline{X})^2}$ and variance 1. This approximation is reportedly good even below $n = 60$, so we will adopt it (9).

This means that we can assume that: b_{yx}/S_{yx} is normally distributed with mean B_{yx}/σ_{yx} and variance $1/\sqrt{\Sigma(X_i - \overline{X})^2}$. Therefore, an estimate of the true discriminability ratio is obtained from b_{yx}/S_{yx}.

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GROUP OPERANT BEHAVIOR: EFFECTS OF TAPE-RECORDED VERBAL REINFORCERS ON THE BAR-PRESSING BEHAVIOR OF PRESCHOOL CHILDREN IN A REAL-LIFE SITUATION*[1]

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A. INTRODUCTION

In a recent report, Antonitis and Barnes (1) described an apparatus and methodology for the study of the free operant behavior of groups of children in the experimentally uncontrolled, real-life environment of a nursery school. Two identical bar-pressing units resembling pedestals were constructed and were installed as permanent fixtures in a nursery-school room. It was hypothesized that if all of the children present in the school daily were allowed to respond freely to the units, depending on the reinforcing consequences, the resulting response records would reflect operation of principles of operant behavior derived from laboratory studies of singly tested subjects. In general, the results of the initial work provided support for this hypothesis. The operant level or "unconditioned" bar-pressing response curves yielded by two groups of children bore certain resemblances to the operant-level curves previously obtained in studies of the unreinforced operant behavior of individual rats and mice (13, 15). The results also showed that the children were strongly reinforced by both the appearance and disappearance of a circular spot of light and pictorial stimuli on a screen above the bar, in much the same way as it has been shown that animals are reinforced by light and patterns of light (e.g., 2, 12).

The present report describes an extension of the group-operant method to

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[1] This research was supported in part by Grant R625-26 from the Wilson Coe Research Fund. Part of the present report is based on a thesis presented by the second author to the Graduate Faculty of the University of Maine in partial fulfillment of the requirements for the M.A. degree in psychology (7). An abbreviated report of the work was presented by the first author at the April, 1962, meeting of the Eastern Psychological Association in Atlantic City, N.J. The authors wish to express their grateful thanks to Mrs. Rose Marie Baron and to Mrs. Elaine Gershman, teachers in charge of the nursery school, for their constant help and cooperation while the observations reported were carried out. Thanks are also due to Mr. William Hamlin and to other students enrolled in the child-study course at the University of Maine for assisting with inquiries and for aiding the work in various ways.

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the study of the reinforcing effects of automatically presented vocal statements (with apparent positive and negative verbal content) on the bar-pressing behavior of two groups of preschool children. The statements were of a kind typically made by adults in attempts to control the behavior of young children; e.g., "That's good!" and "That's bad!" Also investigated were the reinforcing effects of response-contingent, garbled vocalizations and pure tones. While other investigators have shown that human vocalizations exercise reinforcing influences on forms of human operant behavior (e.g., 4, 5, 8, 9), the present work represents a first attempt at studying the effects of apparent positively reinforcing and apparent negatively reinforcing vocal statements on the operant behavior of groups of preschool children in a real-life setting.

B. Method

1. *Subjects*

The subjects were two groups of nursery-school children enrolled in the school conducted by the Department of Psychology of the University of Maine during the spring semester of 1960 (Group 1) and during the fall and spring semesters of the 1960-1961 academic year (Group 2).

Group 1 included 12 children, seven boys and five girls, ranging in age from 42 months to 62 months at the start of observations in February, 1960. Three of the children in this group had been present in the school during the previous year when the second part of the study of the effects of light reinforcement on group operant behavior was being conducted (1).

Group 2 included 22 children, 12 boys and 10 girls, ranging in age from 50 months to 71 months at the start of observations in October, 1960. Six children in Group 2 had been present in the school during the prior year. Three of these six, two boys and a girl, left the school at the end of the fall semester in January, 1961. This reduced to 19 the total number of regularly enrolled Group-2 children in the school during the spring semester of 1961.

The parents of the children in both groups were either members of or close associates of members of the University community.

2. *Apparatus*

The bar-pressing unit developed by Antonitis and Barnes (1) for the presentation of visual stimuli was modified for presentation of auditory stimuli recorded on continuous loops of magnetic tape. Just one of the 51-1/2-inch tall, pedestal-like units described in detail by Antonitis and Barnes was used. The original glass screen that had been used for presentation of visual stimuli was replaced by a cloth-covered, wire screen; and a loudspeaker was mounted inside the unit behind the new screen. Wires were led from the loudspeaker and from a snap-action switch, activated by bar depression and located within the unit, to a distantly situated control room in which was located equipment

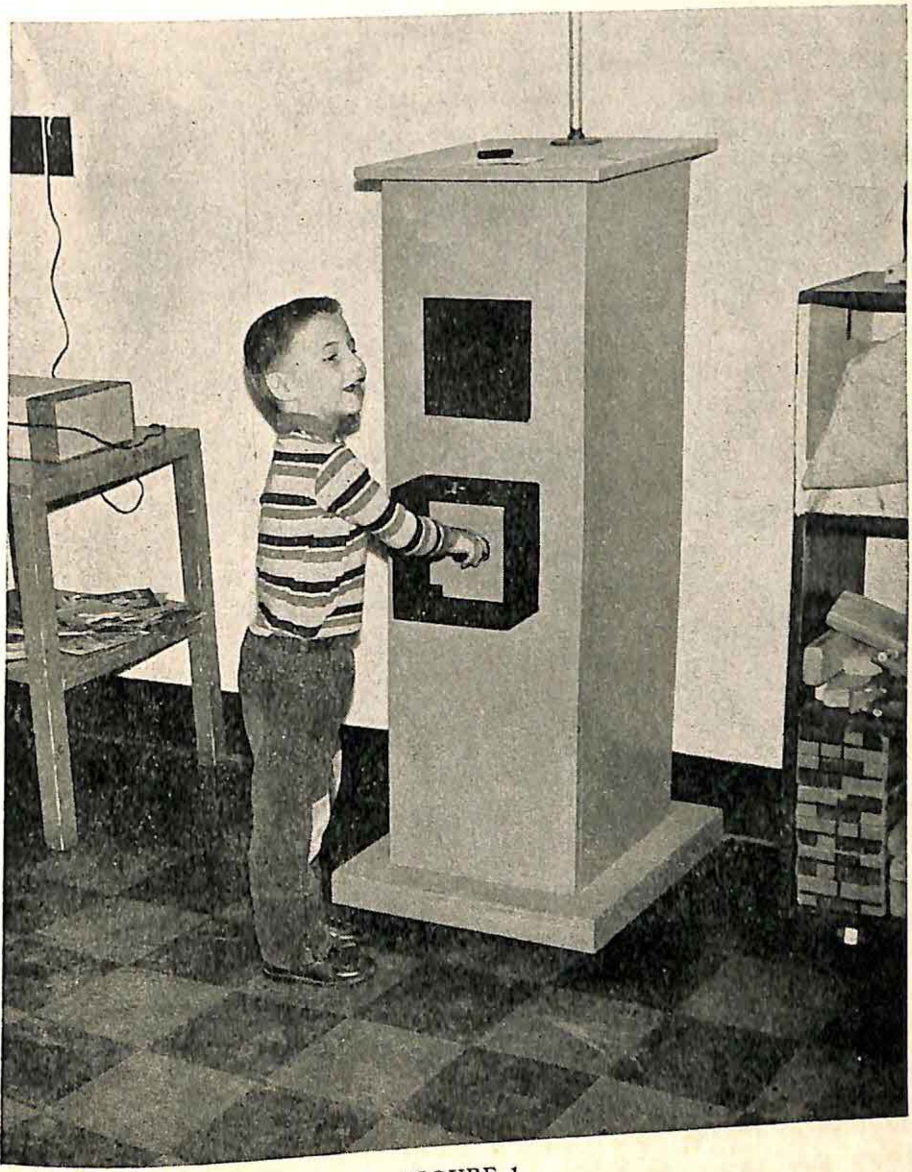

FIGURE 1
PHOTOGRAPH OF THE BAR-PRESSING UNIT

for automatic activation of a magnetic tape player, amplification of sound, and counting of responses. The bar-pressing unit was also modified by addition of a four-inch deep, eight-inch square plywood enclosure around the bar. This enclosure was fitted with a removable cover so that access to the bar could be controlled. The response bar, a one-inch diameter, hardwood, spring-loaded dowel that projected three inches beyond the front panel of the unit at hand height for the youngsters, was not changed. When in use, the bar-pressing unit was situated permanently against a long wall near one end of the 20-foot by 45-foot school room and faced floor space normally used by the children for active and creative play during free-play periods. Figure 1 is a photograph of the unit with one of the subjects responding.

The control system that started and stopped the motor of the magnetic-tape player provided that a momentary depression of the response bar with a pressure of about 14 ounces would "lock in" the motor of the device so that a 32-inch long, continuous loop of magnetic tape would play through, at which point the motor would stop automatically. The "off" action of the mechanism was controlled by a light-sensing cell and an associated sensitive relay activated by light passing through a 6-inch clear section of the tape loop. Inherent in the system was a 2-second delay between bar depression and start of reproduction of the tape-recorded material. Responses made while the tape was playing were recorded, but a response made only after the tape had played through would reactivate the mechanism. The control system also provided that continued depression of the response bar would result in only one playing of the tape; the bar had to be released and depressed again to reactivate the motor of the tape player. With presses properly timed, up to 14.5 reinforcements per minute were obtainable; thus the reinforcement schedule may be described as a fixed-interval schedule. The delay of reinforcement typically resulted in three to seven responses being made by the subjects for each reinforcement.

3. *Procedure of the Main Experiment*

The main experiment (which involved preliminary assessment of responding without reinforcement, followed by assessment of the reinforcing effects of a garbled vocalization, and the statements "That's good!" and "That's bad!" spoken by an adult male voice) was conducted in two replications, with only minor differences in procedure. During the first replication with Group 1, an experimenter remained in the nursery-school room and was seated unobtrusively about 10 feet away from the unit. By means of concealed switches, which operated manually, the experimenter coded on the tape of a print-out counter in the distant control room the responses made by individual children. This was not done in the second replication with Group 2. With Group 2, use of the print-out counter was dispensed with, and simple electric counters were used to accumulate totals of responses made daily by all children and to monitor numbers of reinforcements delivered.

For adaptation purposes, the bar-pressing unit with bar covered was present in the school room for five school days before the start of observations with Group 1; in the instance of Group 2, the unit was present in the room for 15 school days before observations were started.

Once observations were started (each day at 9:00 A. M., the time of final arrival of youngsters at the school) the cover enclosing the bar was removed, and the bar was accessible until the end of the regular daily free-play period between 9:50 and 10:00 A. M. At that time the experimenter or the teacher in charge of the school placed the cover over the bar and locked it in place.

The teacher and other adults present in the school daily were instructed neither to encourage the children to react to the unit nor to discourage them from reacting. The unit was never used in connection with any games or organized activites. If at any time a child asked what the unit was, all adults were instructed to reply simply that it was a toy.

All auditory stimuli were presented at a peak loudness of 83 decibels about .0002 dynes/cm^2 measured at a distance of 12 inches from the loudspeaker port in the bar-pressing unit.

The main experiment, which was carried out over a period of 28 successive school days with Group 1 and then replicated with some modifications over a period of 32 successive school days with Group 2, involved four successive phases as follows:

a. Operant level. During this initial phase, which occupied Days 1 through 6 for Group 1, and Days 1 through 10 for Group 2, no reinforcement other than that provided by sensory effects of lever manipulation followed bar presses. Numbers of such unconditioned bar presses made by the children were simply recorded. Due to the fact that more days were available for observations with Group 2 than with Group 1, the operant-level period for Group 2 was extended to 10 days to obtain a more complete picture of the course of operant-level responding.

b. Garbled voice. During this phase, which occupied six days immediately following the operant-level phase for both Groups 1 and 2, bar depressions were followed by garbled human vocalizations. In the instance of Group 1, this was the sound of "That's bad!" played backwards; in the instance of

Group 2, the stimulus was the sound of the vocalization of "That's good!" played backwards. The garbled vocalizations provided stimuli equal in sound quantity to the stimuli used in the next experimental phase, but these stimuli were lacking in meaningful verbal content and in familiar vocal intonation. The original purpose of this part of the procedure was, first, to obtain a measure of the possible reinforcing effect of a novel auditory stimulus; and, second, to obtain satiation for such a stimulus so that the possible additional reinforcing effect of meaningful verbal content in the nongarbled vocalizations in the next phase would be apparent.

c. Alternation of "That's good!" and "That's bad!" To obtain measures of the possible differential reinforcing effects of two simple statements, one with apparent positively reinforcing verbal content and the other with apparent negatively reinforcing verbal content, the statements "That's good!" and "That's bad!" were presented on alternate days over a period of 10 successive school days for both groups. These statements were chosen in preference to other possible positive and negative statements such as "Right!" and Wrong!" because, in the experimenters' judgments, they appeared to be appropriate in the context of the bar-pressing situation and because they were recommended by the teacher of the school as statements that she often used in attempts to modify the behavior of the children. With Group 1, "That's bad!" spoken in a reprimanding manner was used on the first day of this phase; with Group 2, "That's good!" spoken in an approving manner was used on the first day.

d. "That's good!" vs. "That's bad!" at satiation level. During this final phase of the main experiment, which occupied six days for both groups, the statements "That's good!" and "That's bad!" were presented for three successive days each in an attempt to determine which statement had possibly greater reinforcing potential at the apparent satiation level for reinforcing effects of the two statements. With Group 1, "That's good!" preceded "That's bad!" With Group 2, the order of the two statements was reversed.

4. *Procedure Continued with Group 2*

With Group 2 the observations were extended for the remainder of the academic year to obtain assessments of the reinforcing effects of pure tones and of other, more complex vocal statements with apparent positive and negative verbal content. These observations extended over Days 33 through 102 for this group and involved three major phases as follows:

a. Pure tones. Five days of operant-level or unreinforced responding occupied Days 33 through 37; a two-second long, 1000-cycle pure tone was provided on a response-contingent basis for 10 days (Days 38 through 47); and a two-second long, 250-cycle pure tone was available as a reinforcing stimulus for five days more (Days 48 through 52). The interest in assessing the possible reinforcing effects of pure tones was generated by completion of a study by Barnes and Kish (3) in this laboratory, which study indicated that pure tones (even at optimal low intensities) had only very weak reinforcing properties for mice.

b. "I like that . . ." vs. "Stop that. . . ." The aim in this phase was to investigate the relative reinforcing effects of what might be termed altruistic and sadistic verbal statements on the bar-pressing behavior of the children in Group 2. To obtain a sufficiently large number of readings, the statements: "I like that, press it again." spoken in a pleasant voice, and "Stop that! You're hurting me." spoken in a complaining manner, were presented for 10 days each over a period of 20 successive test days (Days 53 through 72). The two statements were available on alternate days in a counterbalanced *ababababab—bababababa* order.

c. "You're so good today," vs. "You're so naughty today." In this last phase an operant level or unreinforced responding period of 10 days occupied Days 73 through 82 to provide a base level of responding against which the possible reinforcing effects of two more complex vocal statements with apparent positive and negative verbal content could be assessed. The statements used were suggested by the teacher in charge of the school and were, "You're so good today." and "You're so naughty today." The first was spoken in an approving tone of voice; the second, in a disapproving tone of voice. As in the preceding phase, the two statements were available for 10 days each over 20 successive test days (Days 83 through 102), and the statements were alternated from day to day in the same counterbalanced way. The observations with Group 2 terminated on the day before the nursery school closed for the academic year.

In the instance of Group 1, observations occupied 28 successive school days interrupted only by week ends. In the instance of Group 2 (for which group observations extended over 102 days) in addition to week-end interruptions, there were interruptions occasioned by regular vacations, apparatus failures, and field-trip days. Also in the instance of Group 2, on Days 83, 84, and 85, two, three, and three preschool age visitors respectively were present in the school and were allowed to react to the bar-pressing unit; for these three days the data reported below include the reactions of these youngsters. In the captions of the figures presented in the next section of this report, the unusual intervals between successive test days and the days when the visiting children were present have been identified.

C. Results and Discussion

1. *Rationale of Procedure and Treatment of Results*

The present approach to the analysis of the operant behavior of single groups of subjects is similar to that which has been widely adopted by researchers concerned with analyzing the effects of varying conditions of reinforcement on the operant-behavior patterns of individual organisms (cf. 16, 17) and also resembles the approach adopted by Hess (11) in appraising the color preferences of groups of chicks and ducklings. Although the responses of individual subjects were segregated during the observations of Group 1, the treatment of the individual data did not reveal any effects attributable to reinforcing conditions that were not clearly apparent in the group response measures (7). For this reason, when the observations involving Group 2 were carried out, the original procedure of Antonitis and Barnes (1) was followed and group response measures only were collected; therefore in the present presentation and discussion of results, the emphasis will necessarily be on group-response measures.

The totals of bar-pressing responses made daily by the children in both groups were adjusted to take into consideration the varying numbers of children present in the school on different days. Throughout the series of observations with both groups, occasional absences because of illness or other reasons was the rule rather than the exception. The adjustment of the group totals of responses made daily was accomplished by dividing the totals by the numbers of children present.

2. *The Main Experiment*

Figure 2 shows the results that were obtained during the 28-day series of observations with Group 1. In this figure, and in the other figures that follow, the mean number of responses per child present in school on each day has been plotted against successive test days. The letters M, T, W, etc., on the horizontal axis indicate the days of the week. The tables in the panels show the numbers of children present in the school on given numbered days.

It is clear, from the data in the extreme left panel of Figure 2, that responding during the operant-level or unreinforced phase was very low. Further, the "curve" does not have the shape of the operant-level curves obtained in the first group-operant-behavior studies of Antonitis and Barnes (1). The reason for this initial low operant-level response rate with this group is not clear. It will be noted that responding is higher on Day 6 than on preceding days; the experimenter's notes indicate that on that day most of the presses were made by just three children who played a game that they called "making handprints." They put one hand on the velvet cloth over the loudspeaker port and pressed the bar with the other hand.

On Day 7 (a Wednesday) no responses to the unit were made until 10 minutes before the end of the experimental period, but then the garbled voice

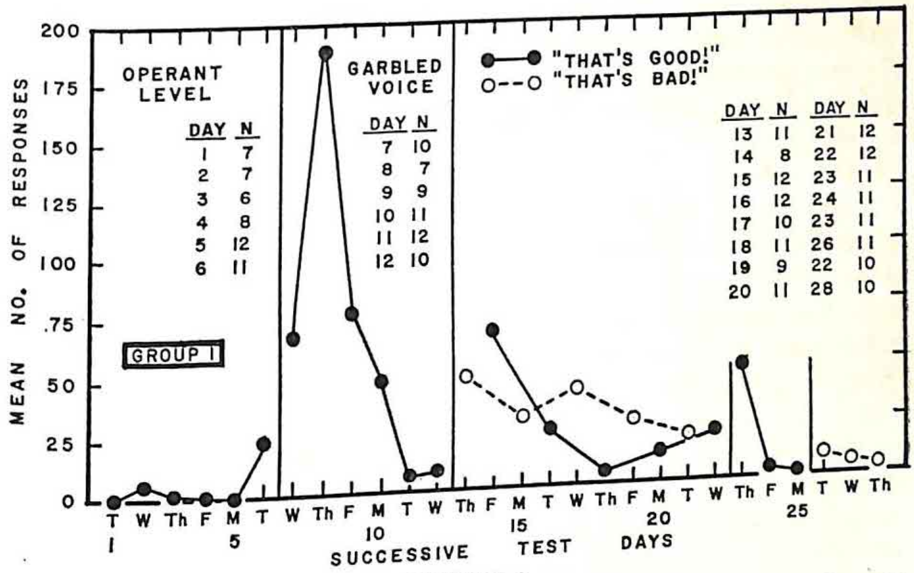

FIGURE 2

MEAN NUMBER OF RESPONSES PER DAY PER CHILD IN THE OPERANT LEVEL, GARBLED VOICE, AND "THAT'S GOOD!" *vs.* "THAT'S BAD!" PHASES OF THE MAIN EXPERIMENT WITH GROUP 1

The tables in the panels show the number (*N*) of children present in the school on each test day. The letters T, W, Th, etc., on the horizontal axis designate the days of the week.

consequence of bar pressing was discovered, and in the 10 remaining minutes six out of 10 children responded most actively to the unit. The mean number of responses per child (the total number of responses divided by 10, the number of children present in school) on Day 7 was 66.7. On the next day, with seven out of seven children present responding, the mean number of responses was 188.0. One child pressed the lever 806 times; the lowest responder pressed it 13 times. Seven children in the group of 12 were present in school on both the last two operant-level days and on the first two garbled-voice days. Considering just these seven children, the mean number of responses made on the last two operant-level days was 38.1 and the mean number of responses made on the first two garbled-voice days was 259.1. All the totals of responses made by the seven children on the two garbled-voice days were greater than the totals that they made respectively on the two immediately preceding operant-level days. Wilcoxon's test of paired replicates applied to these two-day totals of responses yields a p of .02. Without the preceding crude statistical analysis of individual data, a comparison of the data obtained in the garbled-voice phase with the operant-level data (as shown in the first two panels of Figure 2) shows that the garbled vocal sound of "That's bad!" played backwards exercised a positively reinforcing effect on the bar pressing of the children in Group 1.

Figure 2 shows that responding under the garbled-voice reinforcing condition declined by Day 11 to a level approximating that of responding during the operant-level period. Only six children in the group of 12 were present in school on both the first two and the last two days of the garbled-voice phase. The mean two-day totals of responses made by these six children declined from 278.8 to 13.5 from the first two to the last two garbled-voice days; this decline in responding, when assessed with Wilcoxon's paired-replicates test is significant at the .05 level.

Figure 2 shows that, when the statements "That's bad!" and "That's good!" were introduced and alternated over Days 13 through 22, there was an immediate increase in responding as compared with the low level of responding on Days 11 and 12, the last two garbled-voice days. The mean response scores plotted in Figure 2 for this phase also suggest that the two statements had about equal strengthening effects. For the sake of a crude statistical appraisal of the reinforcing effects of the two comprehensible vocal statements, means of the scores for each of the 12 children on the *last* two days when they were present in school during the garbled-voice phase, and the means of the scores that they yielded on the days when they were present during the 10-day "That's good!" vs. "That's bad!" phase were computed. In the latter instance two scores, one for the "That's good!" days and one for the "That's bad!" days were obtained for each child. Among the 12 scores for the garbled-voice phase, 10 were based on responding during Days 11 and 12; and two, on responding during Days 10 and 11. Among the scores for the "That's good!" days, six were based on responding over five days; and six others, on responding over four days. Among the scores for the "That's bad!" days, two were based on three days of responding, two others were based on four days of responding, and eight were based on responding on all five days. The mean of the two-day mean scores for the 12 children at the end of the garbled-voice phase was 9.0. The means of the three- to five-day mean scores for the "That's good!" and "That's bad!" days, respectively, were 23.1 and 33.2. Wilcoxon's paired-replicates tests indicate that the mean response frequencies of the children were increased significantly by both statements, the *p* being .05 for the increase attributable to "That's good!" and less than .01 for the increase attributable to "That's bad!" Another paired-replicates test shows that the means of the three- to five-day mean individual scores for the "That's good!" and "That's bad!" days do not differ significantly.

Figure 2 shows that responding during the satiation-level phase, Days 23 through 28, was very low for both statements; and responding on Day 23 only, a "That's good!" day, exceeded the highest (or Day 6) mean operant-level response frequency. There is no indication in the data of this terminal phase that one statement was more reinforcing than the other; the indication rather, is, that both statements lost their reinforcing potentials almost completely.

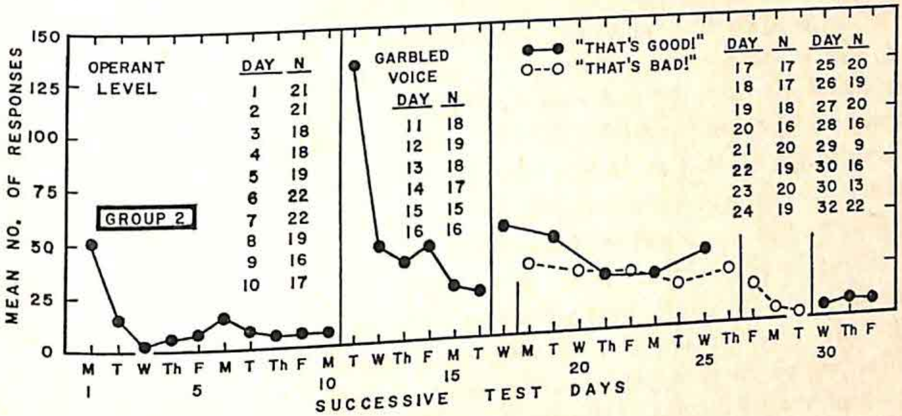

FIGURE 3

RESULTS OBTAINED IN THE REPLICATION OF THE MAIN EXPERIMENT WITH GROUP 2

An interruption of one day due to apparatus failure before the test session began occurred between Days 7 and 8. The vertical line between Days 17 and 18 indicates a four-day interval between test sessions due to the Thanksgiving vacation period.

Figure 3 shows the results that were obtained when the same series of observations were replicated with some modifications with the second group of children during the following school year. The extreme left panel of this figure shows that Group 2 yielded a uniform operant-level curve highly similar to the operant-level curves obtained in the first group-operant behavior studies (1). The curve shows a slight rise on Day 6 (a Monday) which rise suggests a mild degree of spontaneous recovery of reactivity to the bar-pressing unit over the week end.

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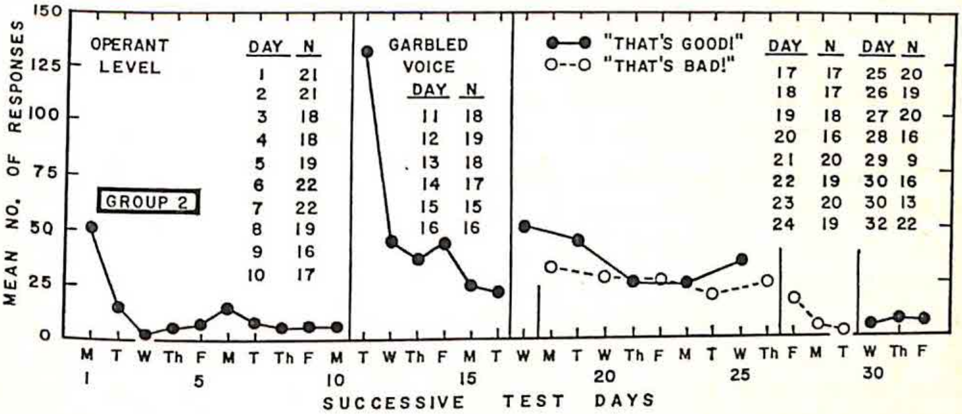

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With Group 2, the garbled-voice sound provided during the second phase was the statement "That's good!" played backwards. The center panel of Figure 3 shows that, as in the instance of Group 1, the novel sound exercised a massive strengthening effect on group bar-pressing behavior. The group mean response frequency on the last operant-level day was 6.6; on the first garbled-voice day, the mean number of responses per child present increased to 131.4. Paralleling the Group 1 results, responding in this phase declined with successive days; but mean numbers of responses on the last two days of this phase, 25.5 and 22.3, respectively, were still well above the mean response frequency of 6.6 that prevailed over the last three operant-level days (Days 8, 9, and 10).

The massive reinforcing effect of the garbled voice (as indicated in the data of both groups) may be explained in terms of sensory reinforcement or in terms of secondary reinforcement or in terms of both concepts. When procured, the garbled voice could be held to have provided a sensory reinforcing consequence (it was a sound), and also to have provided a secondary reinforcing consequence (it was a human voice and—observations showed—it was definitely recognized as such by the youngsters).

Figure 3 shows that, when "That's good!" and "That's bad!" were introduced—from Day 17 on for Group 2—the daily mean numbers of responses initially increased somewhat over the mean numbers of responses on the last two garbled-voice days. Comparison of the data in the extreme right panels of Figures 2 and 3 indicates that the magnitude of the increase in responding occasioned by the introduction of the intelligible statements is fairly similar for Groups 1 and 2. In the instance of Group 2, the daily mean number of responses per child for the first five "That's good!" days was 36.1; and for the first five "That's bad!" days, 26.4. When these means are added to the corresponding means yielded by Group 1 for the first five "That's good!" days (23.1) and the first five "That's bad!" days (33.2), the two sums obtained (59.2 and 59.6 respectively) are practically identical. When the data of the two groups are considered together, the conclusion is that the two statements exercised equal positively reinforcing effects on the bar pressing of the children.

Again, as in the instance of Group 1, the satiation-level measures of the reinforcing potentials of the two statements on the behavior of the children in Group 2 (Days 27 through 32 in Figure 3) do not indicate that one statement is more or less reinforcing than the other, but do indicate almost complete losses of reinforcing potentials by both statements.

The finding that the presumed negative reinforcer, "That's bad!" did not have a suppressive effect on bar pressing may be understood, perhaps, when the procedures of the present study are considered. Although the study was carried out in a real-life setting, the statement "That's bad!" as presented was not accompanied by other social cues such as would be provided in the home or in the school by the actual presence of a speaking adult; nor was it ever accompanied by some more primary form of negative reinforcement. Further, the stimulus was procured in the safe environment of the nursery school—in the presence of other children and reassuring adults—and its procurement was under the complete control of the responding children. In line with the discussions on affective arousal, by Hebb (10) and by McClelland and the latter's associates (14), it is suggested that stimuli that would ordinarily arouse anxiety or apprehension in preschool children (when encountered in uncontrollable, natural situations) may have stimulating and pleasurable effects when procured by children in controllable, safe situations. The hypothesis offered here in partial explanation of the present results is that procurement of a cue for negative reinforcement in a controllable, nonpunitive environment may function in a positively reinforcing way.

Observations of the children's reactions to the unit, reported in greater detail below, suggest the strong possibility that at least some children experienced still another form of positive reinforcement on procurement of the negative statement, "That's bad!" A not uncommon reaction of the children in both groups to "That's bad!" and of the children in Group 2 to the other negative statements that were used was some form of aggressive behavior. Some children appeared to be using the talking "man-in-the-box" as an object for displaced hostility. For these children, the expression of hostility and consequent reduction of emotional tension may have served as an additional form of positive reinforcement [cf. (6)].

3. *Continued Observations of Group 2*

It will be recalled that with Group 2, observations were continued to explore the possible reinforcing effects of additional auditory stimuli: namely, pure tones and other complex vocal statements.

Figure 4 presents the results that were obtained during the pure-tone phase. The figure, in the extreme left panel, shows the mean numbers of responses made by the children in Group 2 over several operant-level or unreinforced responding days (Days 33 through 37), which days preceded the introduction of pure tones as reinforcers. Because this phase followed the "That's good!" *vs.* "That's bad!" reinforcement phase, it may also be regarded as an extinction period; however the data do not reveal presence of any marked degree of residual strength attributable to prior reinforcement. The mean scores for Days 33 through 37 ranged between 4.0 (on Day 36) and 15.9 (on Day 37). This range is similar to the range of mean scores over Days 6 through 10, the last five initial operant-level phase days (left panel of Figure 3). The latter range was from 6.5 (on Day 8) to 15.4 (on Day 6). Whether or not carry-over of the reinforcing effects of the vocal statements to a subsequent extinction period would have occurred had observations not continued until the youngsters were clearly satiated with these stimuli can only be conjectured. It is of some interest to note that during this period some youngsters expressed various hypotheses as to why sounds no longer issued from the talking box. One child, for example, informed the experimenter that the unit was broken; another, after a few bar depressions, said "The froggy in the box is sick and had to stay home in bed."

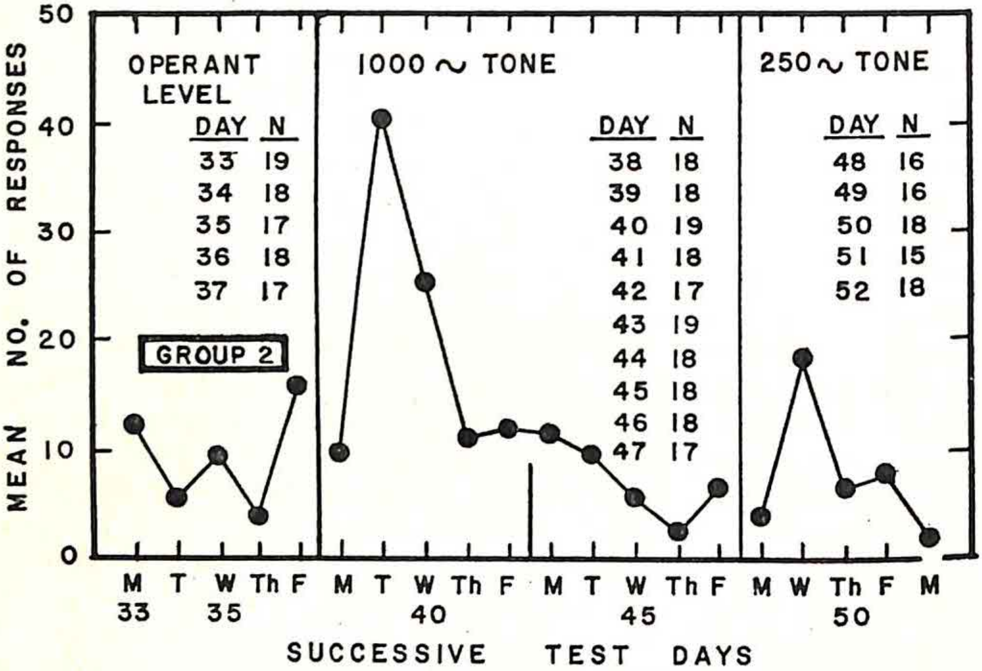


FIGURE 4

Results Obtained during the Pure-Tone Phase of Observations with Group 2

The Christmas vacation was responsible for an interval of 23 days between Day 32, the last day of the main experiment, and Day 33, the first operant-level test-day of the present phase. The vertical line between Days 42 and 43 indicates another break of 24 days occasioned by the midyear examination period. Apparatus failure was responsible for a one-day interval between Days 48 and 49.

The center and right panels of Figure 4 show what happened when 2-second pure tones of 1,000 and 250 cycles per second respectively were presented to the children at the same intensity as the peak intensity of the vocal statements: namely, 83 decibels as measured 12 inches from he loudspeaker port. On the first day, when the 1,000-cycle tone was available (Day 38), two boys discovered this at about 9:00 A.M., while the other youngsters were still in the teacher's office having their throats examined. The boys did not communicate their discovery to the other youngsters, and the other youngsters simply did not respond that day so were unaware that the tone was available. On the next day (Day 39) when awareness of the new reinforcing stimulus became general, the mean number of responses per child rose to 40.6, well above the mean score of 15.9 on Day 37, the last day preceding unreinforced responding. By Day 41, however, responding declined to the unreinforced level. Clearly, on first introduction, the 1,000-cycle tone exercised some reinforcing effect; but the youngsters became satiated with it rapidly. The present result may be compared with recent findings of Barnes and Kish (3) concerning the reinforcing effects of pure tones on lever-contact behavior in mice. In general, the findings indicate that response-contingent pure tones below 6,000 cycles function only as weak sensory reinforcers at intensities below 75 decibels. For mice, a tone of 1,200 cycles at 85 decibels has little apparent reinforcing influence either positive or negative. The suggestion from this comparison is that sensory reinforcers reinforce different species in different degrees.

On Day 48, when the lower 250-cycle tone was introduced, the data do not indicate (see Figure 4) that responding increased over the rate of responding that prevailed toward the end of the 1,000-cycle tone period. It may be that satiation with the 1,000-cycle tone generalized to the 250-cycle tone, but this is only a conjecture.

Figure 5 shows the results obtained when tapes with the statements, "I like that, press it again." and, "Stop that! You're hurting me." were alternated over a 20-day period. The data obtained during the immediately preceding 250-cycle tone phase are presented again in the left panel of Figure 5 to provide a convenient base level, approximating the initial operant level, against which the reinforcing effects of the two statements may be appraised. The aim here originally was to investigate the relative reinforcing potentials of what might be deemed altruistic and sadistic verbal statements, but an inquiry conducted among the children toward the end of this phase showed that they did not understand the "You're hurting me" part of the intended sadistic statement and apparently responded only to the initial "Stop that!" of the statement, interpreting it as a negative command. Each of the youngsters was asked by a student assistant what it means "to hurt." Fourteen out of 18 youngsters replied that they did not know, two said it meant "stop that." one said it meant "like to hit." and one said it meant "do it again." Further inquiry revealed that at least eight out of the 18 youngsters did interpret "Stop that!" correctly as a negative command, but seven said that they did not know what "Stop that!" meant. Among the remaining three, one child said that it meant, "You're hurting me." another said it meant, "It hurts." and the third said it meant, "It's tired."

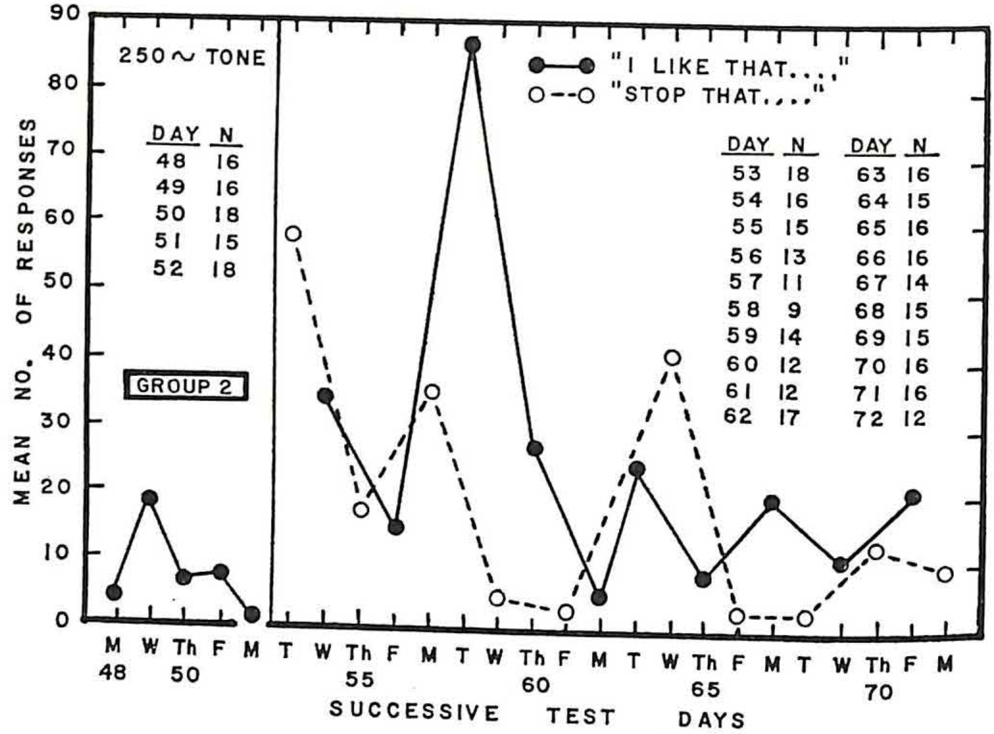
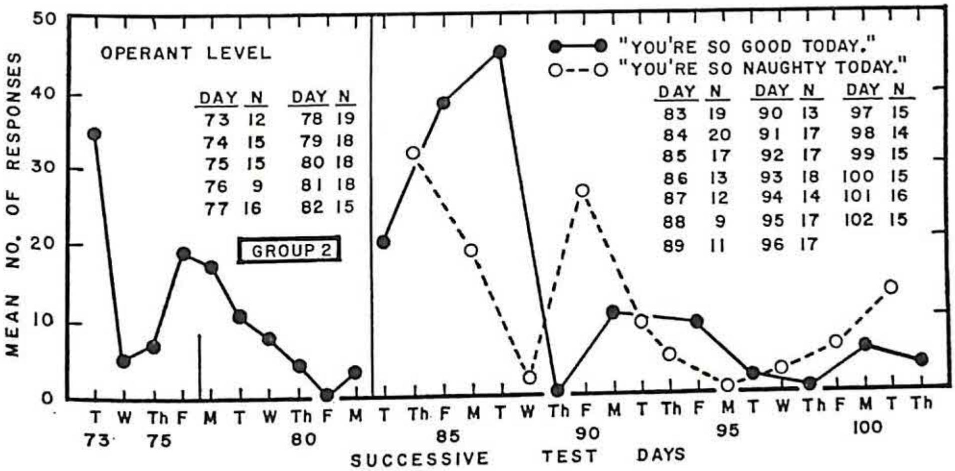


FIGURE 5

Results Obtained in the "I Like That . . ." *vs.* "Stop That . . ." Phase with Group 2

Results obtained in the preceding 250-cycle tone phase are presented again in the left panel of this figure for purposes of comparison.

Figure 5 shows that both statements initially exercised powerful reinforcing effects, and that these effects declined with successive days. Despite large day-to-day differences in mean numbers of responses, which may indicate that the children were becoming satiated in general with the talking box, the overall impression yielded by each of the "curves" is one of fundamental, underlying regularity in the decline of responding. Over the 10 days each that the "Stop that . . ." and "I like that . . ." statements were available, the daily mean totals of responses per child to the two statements were 19.7 and 22.6 respectively. Since this is not a very large difference, and since Figure 5 shows a high degree of overlapping of the ranges of scores represented in the two curves, the best conclusion is that both statements functioned as positive reinforcers in about equal degrees. Though negatively reinforcing in its implication, "Stop that . . ." functioned as a positive reinforcer in the same way that "That's bad!" previously functioned as a positive reinforcer for the children in this group. The explanation given above for the reinforcing effect of "That's bad!" is equally applicable in explanation of the reinforcing effect of "Stop that. . . ."



DAY	N	DAY	N
73	12	78	19
74	15	79	18
75	15	80	18
76	9	81	18
77	16	82	15

DAY	N	DAY	N	DAY	N
83	19	90	13	97	15
84	20	91	17	98	14
85	17	92	17	99	15
86	13	93	18	100	15
87	12	94	14	101	16
88	9	95	17	102	15
89	11	96	17		

FIGURE 6

Results Obtained in the Final Phase of Observations with Group 2 when the Statements Indicated in the Right Panel Were Used as Reinforcers

The vertical line between Days 76 and 77 indicates a nine-day time-out period due to the spring vacation. A one-day vacation intervened between Days 83 and 84, and youngsters were on field trips on the Wednesdays between Days 92 and 93, and between Days 101 and 102. On test Days 83, 84, and 85, two, three, and three additional preschool children respectively were in the school as visitors; the *N*s listed in the table for these three days include these visiting youngsters who were allowed to respond to the bar-pressing unit.

Figure 6 shows the results obtained with Group 2 during the last 30 days of observations near the end of the academic year. Once again an operant-level or extinction period was introduced for 10 days to obtain a base level of responding. Because the mean number of responses on Day 73, the first day of unreinforced responding that followed immediately after the last "Stop that . . ." day, was 34.9, the magnitude of this mean—as compared with the last "Stop that . . ." mean (9.4) and with the final stable daily mean number of responses that prevailed in the first operant-level phase (6.6 for

Days 8, 9, and 10)—indicates some carry-over of the reinforcing effects experienced by the children during the preceding phase; but the carry-over is not apparent on the second day of unreinforced responding. Once again, observations indicate that at least two children expressed hypotheses to the effect that he bar-pressing unit was "broken."

In Figure 6 it may also be seen that when the statements "You're so good today." and "You're so naughty today." were introduced as consequences of bar depressions, mean numbers of responses rose markedly at the start of this phase with an indication that the complimentary statement was preferred. After four or five days of each of the statements, however, responding declined to approximate the operant-level rate. Over the 10 days when "You're so good today." was presented, the daily mean number of responses per child was 13.9; over the 10 "You're so naughty today." days, it was 12.4. The difference between these means is so slight that (again) the conclusion is that both statements functioned as positive reinforcers in about equal degrees. And again the explanation offered to account for the positively reinforcing effect exercised by "That's bad!" appears to be applicable in explanation of the positively reinforcing effect of "You're so naughty today."

4. *Observations of Other Reactions of Subjects*

The present report would not be complete without brief mention of the nature and variety of reactions (other than bar-pressing) made by the children in Group 2 to the talking box over the year of study. From the very start of observations, it was clear that the statement "That's bad!" aroused defensive and aggressive reactions on the part of a number of the youngsters. On one "That's bad!" day, for example, four youngsters were observed at the unit pressing the bar to procure the statement, then shouting in chorus, "No! That's good!" During this period, so many fists pounded the velvet-covered wire grill over the loudspeaker port that the grill had to be replaced with one of sturdier construction.

Aggression toward the "man-in-the-box" was similarly frequent during later verbal-statement periods. Boys, especially, were often observed kicking the box and striking it with fists and with wooden blocks. One boy who responded to the unit daily would go over to the box, press the lever, procure the statement, then shout while pounding the speaker grill with his little fist, "Shut up, you bastud!" One day he was observed attacking the box vigorously with a length of "two-by-four" wood intended for use by the youngsters as a building block when the "man-in-the-box" was saying, "You're so good today." When asked by the experimenter why he was doing this, he replied, "I don't like it 'cause sometimes it says, 'That's bad!' " Observations such as these provided the basis for the inference offered that the positively reinforcing effects of the negative statements could be understood in part as reflecting tension relief following acts of displaced hostility.

Perhaps because of personality differences, not all youngsters developed hostile attitudes toward the "man-in-the-box." At least one youngster, a girl, developed an opposite, friendly attitude. During the spring semester a student assistant conducted a sociometric survey in the nursery school, asking each of the children to name the one they liked best in the school. After thinking a moment, this little girl replied, "The man in the box."

5. *General Conclusions*

Considering all of the data yielded by both groups, the general impression is that each time a new auditory stimulus was introduced in a reinforcing relationship to bar pressing, regardless of its nature or of its apparent positive or negative verbal content, the stimulus functioned to strengthen bar-pressing behavior. And with continued presentation the stimulus lost its reinforcing potential. The course of change in reactivity of the children to the auditory stimuli used in the present study parallels the course of change in reactivity that was observed in the first group operant-behavior studies (1) in which a lighted stimulus screen and pictorial stimuli were employed as reinforcers. Further, the results of the first studies (1) and of the present observations appear to parallel the commonly observed course of change in reactivity of human beings and animals in general to novel, nonorganically reinforcing stimulus situations in general. The results of the group operant-behavior studies that have been performed thus far suggest the following general principle of behavior, which principle may be equally applicable in prediction of the reactions of organisms to both novel and sensory reinforcing stimuli and to stimuli that may be termed secondary reinforcers. On first encounter, a novel or secondary reinforcing stimulus situation attracts behavior because of the sensory impression it makes or because of the mild emotional reaction or thrill that it arouses. With repeated encounters, if there is no association of the stimulus situation with reduction of any organic drive state, the stimulus situation (more or less rapidly, depending on its nature and on individual and other variables) loses its potential to elicit a sensory or emotional reinforcing effect. With repeated encounters, loss of the reinforcing potential of the novel or secondary reinforcing stimulus situation follows a negatively accelerated function.

D. SUMMARY

A group-operant technique was used to investigate the reinforcing effects of automatically presented, tape-recorded auditory stimuli on the bar-pressing behavior of preschool children in the real-life environment of a nursery school. The auditory stimuli included garbled vocalizations, intelligible vocal statements with apparent positive and negative verbal content, and pure tones that were delivered on a response-contingent basis via a loudspeaker-equipped bar-pressing unit which was a standard fixture in the nursery-school room. Two groups of children were observed, one for 28 daily sessions and the other for 102 daily sessions. The objective data collected consisted of total numbers of bar depressions made daily by all children present in the school during a one-hour free-play period. In the instance of the group observed for 28 days, an observational technique that provided for segregation of responses made by individual children was also used.

The results showed that, regardless of apparent positive or negative verbal content, vocal statements such as "That's good!" and "That's bad!" when first introduced functioned to strengthen bar pressing by the children. Aggressive response tendencies, however, were elicited in some children by the negative statements. Garbled vocalizations also functioned initially as powerful reinforcers, but a pure tone of 1,000 cycles was found to be only weakly reinforcing. Responding to each of the auditory stimuli declined with successive days. Several hypotheses are offered to account for the results.

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THE PARENTAL EARLY REPRESSIVENESS HYPOTHESIS FOR THE "AUTHORITARIAN" PERSONALITY FACTOR, U. I. 28*

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A. INTRODUCTION

Over the last six years, encouraging progress has been made toward more penetrating interpretation of several of the 21 personality factors known to be replicable in objective-test measures. Scheier [see Cattell and Scheier (13)] clarified what is now recognized as the anxiety factor; Eysenck (19), the ergic-regression or neuroticism factor; and Weiffenbach (15), cortertia and other factors—while Cattell (12), and Hundleby and Pawlik (22), have examined and developed a whole series of factor hypotheses in the light of new results. Among these comparative successes, the source trait hitherto recorded in the universal index (4) as U. I. 28 stands out egregiously as a persisting enigma. To obtain some advance, this paper surveys up-to-date evidence and discusses desirable crucial experiments in relation to hypotheses for U. I. 28.

For social psychologists, U. I. 28 holds particular interest because its content places it as one of the few firm personality structures arising in the general region where once stood the defunct notion of the "authoritarian personality." This latter notion, incidentally, has been regarded by many serious investigators as the offspring of a doubtful liaison of science and propaganda, for it did not appear as the result of any initial statistical-experimental demonstration of a formally existing source trait (factor), or surface trait, or even of a formal type in any possible statistical sense of type (4, 23, 27). Indeed, its superficial appeal to political and familial emotions distracted much research, especially by students, from basic advance in personality structure.

Meanwhile, in the experimental realm of objective, nonquestionnaire personality measurement there appeared a factor pattern, five times replicated in independent experiments by 1955 (3, 8, 10, 16), that clearly was relevant to various aspects of authority-relation behavior. With this authority-reaction aspect, however, there was also a much richer presentation of diverse reactions of other kinds that promised a more comprehensive interpretation.

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At the same time, the appearance of four other factors (U. I. 16, U. I. 20, U. I. 21, and U. I. 30) with significant loadings on various reactions to authority showed that authority responses *in toto* are very complexly determined. This broader approach vindicated the narrower indications in the four-and five-dimension factorizations of questionnaire authority (i.e., F Scale) evaluations, by O'Neill and Levinson (24) and others, to the effect that the total dynamics of this realm of behavior must be much more complex than any simple authoritarian-*vs.*-nonauthoritarian personality dimension.

As will become evident, however, the U. I. 28 dimension has importance not only in regard to the general relations of the individual to the group, but also in regard to internal conflict and maturation rates in individual personality development.

B. Methodology of Source-Trait Interpretation

In developing interpretive hypotheses for personality factors, adherence to a regular methodological procedure has been found most effective. This procedure is as follows:

1. To examine the goodness, in hyperplane count and statistical significance, of the *simple structure* reached by blind, independent rotation in the contributory collated factor studies. The 10 studies in Table 1 were blind and independent and reached hyperplane counts averaging approximately 59 and 60 per cent.

2. To check, by Cattell's index (6) or in other ways, the significances of matching agreement of the factor patterns thus independently obtained. Those for factors in Table 1 are satisfactory, as more fully set forth elsewhere (22).

3. To consider first hypotheses as suggested by the loading pattern: i.e., by the nature of the variables that (*a*) load highly positively, (*b*) highly negatively, and (*c*) do not load, *though included in the studies.* This is a complex feat of intellectual abstraction because one must, at the same time, *compare the pattern with that of other factors.* It is a common mistake to give an interpretation believing it to be unique to Factor X only to find that there exists a Factor Y sharing with Factor X so many variables that the hypotheses for Factor X should have been much more restrictive.

4. To ask what is the rank order of general variance of the factor among factors, and whether it is found also (and with what modifications?) at other ages and in other populations.

5. To inspect its correlations with questionnaire or life-record (rating) factors.

6. To examine the nature-nurture ratios, both between families and within

TABLE 1

THE REPLICATIONS OF THE LOADING PATTERN OF U. I. 28 IN 10 INDEPENDENT RESEARCHES

Master index number (13)[1]	Title of behavioral measure[2]	Loadings in various studies[3]									
		Adult males and females ($N =$ 100)	Psychotic males and females ($N =$ 100)	Adult males ($N =$ 500)	Adult males ($N =$ 250)	Adult males and females ($N =$ 86)	Adult males and females ($N =$ 86)	Adult males ($N =$ 168)	Male and female children ($N =$ 184)	Male and female children ($N =$ 164)	Male and female children ($N =$ 197)
123	Higher estimates of passing time when working than when relaxing.	+05	+52		+52			+61	+64		
97	Greater length of estimated passing time.	—00	+51					+59	+76		
191, 295	Less considered possible in given time for others.	+16	+17						+41		
103, (2) (192)	Less considered possible in given time for self.	+46	+27					+38	+35	+18	
280	Less accuracy of passing time estimates.			—18	—11			—52			—10
152, 195	Much tendency to agree.	+25	+35	+28	+33	+53	+28		—03	+01	

[1] The M.I. (Master Index) numbers on the left (occasionally with letter) are the means whereby the researcher can identify, in the objective personality test compendium (14), and replicate the measurement operations used.

[2] The measurement operation descriptions have been adjusted to the signs of the loadings (e.g., *Less* accuracy, etc., is written for M.I. 280 because the loading is negative on a test of accuracy scored positively).

[3] A blank in the loading row or column does not mean an insignificant result, but simply that the measure was not included in that research.

TABLE 1 (*Continued*)

Master index number (13)[1]	Title of behavioral measure[2]	Loadings in various studies[3]									
		Adult males and females ($N=$ 100)	Psychotic males and females ($N=$ 100)	Adult males ($N=$ 500)	Adult males ($N=$ 250)	Adult males and females ($N=$ 86)	Adult males and females ($N=$ 86)	Adult males ($N=$ 168)	Male and female children ($N=$ 184)	Male and female children ($N=$ 164)	Male and female children ($N=$ 197)
38	Higher ratio of consonant to dissonant opinion recall.	+18	—02	+28	+20						
246	Much authority submission.			—27	—26				—00	—04	
35	Much shift of attitude toward the attitude endorsed by authorities.	+27	+34	+29	—09				+20		
193	Much shift of attitude toward the attitude endorsed by successfuls.	—04	+10	+32	—01				+18		
194	Much shift of attitude toward the attitude not endorsed by neurotics.	+16	—04	+38				+10	—04		
211	More susceptible to annoyance.			+28	+12				+10	+04	+01
67	Much extremity of viewpoint.	—01		+30	+33				+04	+13	+13

TABLE 1 (*Continued*)

Master index number (13)[1]	Title of behavioral measure[2]	Loadings in various studies[3]									
		Adult males and females ($N =$ 100)	Psychotic males and females ($N =$ 100)	Adult males ($N =$ 500)	Adult males ($N =$ 250)	Adult males and females ($N =$ 86)	Adult males and females ($N =$ 86)	Adult males ($N =$ 168)	Male and female children ($N =$ 184)	Male and female children ($N =$ 164)	Male and female children ($N =$ 197)
116	Much critical severity in judgments on social issues.	—08	+46	+22		+20	+31		—09	+27	
108	Less self-confident of skill in untried performance.	—31	—09	+03	+15	—25	—11	+03	—08	—08	
107	Less knowledge of social etiquette.	—22	—27								
7	Fast speed of perceptual Gestalt completion.	—01	+19	+27	+20				+09	+04	+02
8	Slow speed of alternations on test of reversible perspective.	—32	—03	+11					+03	+04	
120	Higher ratio of accuracy to speed.	+05	+05			+27	+01	—01		+39	+09
335	Slow reaction time under complex instructions.										+34

TABLE 1 (*Continued*)

Master index number (13)[1]	Title of behavioral measure[2]	Loadings in various studies[3]									
		Adult males and females (*N* = 100)	Psychotic males and females (*N* = 100)	Adult males (*N* = 500)	Adult males (*N* = 250)	Adult males and females (*N* = 86)	Adult males and females (*N* = 86)	Adult males (*N* = 168)	Male and female children (*N* = 184)	Male and female children (*N* = 164)	Male and female children (*N* = 197)
154	Many slanting lines crossed —CMS.	+01	+02			+33	+29	—04			
375	High speed and accuracy in circle cancellation.									+33	
339	Slow speed of mirror-drawing performance.									+46	+68
357	Higher total distance covered in mirror drawing performance.									+45	+67
197, 170	High ideational rigidity—hidden pictures (a priori key).	+36	—08	+17					+16		
763	Much fluency on people's personal characteristics.			+33	+23						
316	Higher fluency on own characteristics.					—06	+30			+32	
443	Lower absolute PGR resistance level.					—15	—57				

TABLE 1 (*Continued*)

Master index number (13)[1]	Title of behavioral measure[2]	Loadings in various studies[3] Adult males and fe-males ($N =$ 100)	Psy-chotic males and fe-males ($N =$ 100)	Adult males ($N =$ 500)	Adult males ($N =$ 250)	Adult males and fe-males ($N =$ 86)	Adult males and fe-males ($N =$ 86)	Adult males ($N =$ 168)	Male and fe-male chil-dren ($N =$ 184)	Male and fe-male chil-dren ($N =$ 164)	Male and fe-male chil-dren ($N =$ 197)
212	More distant goals considered attainable.			+06					+35		+11
T96-(1)	Less suspicion towards higher occupational groups.							—39			
T102-(1)	Small size of drawings of trees and people.							—38			
	Bibliographic reference	(10)	(15)	(3)	(3)	(12)	(11)	(18)	(8)	(7)	(9)

families. It would be fruitless to devote much time to a temperamental theory when the initial "sorting" points to an environmental explanation or to go far with learning theories if the evidence points clearly to a predominantly hereditary explanation.

7. To examine age trends in the factor score.

8. To look at the second-order structure among objective-test factors, in which the given factor might be involved.

9. To look for any evidence of *state* factors (P or Incremental R technique) akin in pattern to the trait.

10. To examine correlations with (or group difference on) particular life criteria: e.g., school success, clinical problems, delinquency, etc.

11. To seek evidence of effects of manipulative experiments upon factor scores.

12. To study closely, in a clinical sense, the behavior of *individuals* known to be extremely high or extremely low on the factor measurement.

C. The Factor Pattern

Pursuing the foregoing methodology with U. I. 28, we begin with the factor pattern as shown in Table 1. The values shown are correlations with the reference vectors, but these are proportional to the loadings (2) and suffice for the purpose. No fewer than seven independent studies exist for adult groups (normal and abnormal) and three for children. The variance rank order of the factor gives it a middling status of importance.

As usual, the vicissitudes of rotation and sampling produce appreciable variations in *absolute* magnitudes of loadings, but sign direction and significance are highly constant. Perhaps three features of the behavior involved in this factor can be singled out for mention, though there is no substitute for studying *all* variables *per se*.

First, there is a peculiarity in perceiving time. It is conceived as experienced time (MI. I 97, 123, 280) or as conceptual (M. I. 103, 191, 295) time. Time passes slowly when the high U. I. 28 person works, and he also considers little possible for himself (low aspiration), relative to others, in any conceived time. He also considers few distant goals attainable.

Second, the individual believes in and accepts authority (authority submission, M. I. 246) and shifts his opinions toward authority when he is told what authority believes (M. I. 35). Similar to this, he shifts his opinions away from those stigmatized as neurotic (M. I. 194) and toward those of people designated as successful (M. I. 193).

Third, the pattern contains a set of variables that also appear loaded on the anxiety factor, U. I. 24, and on comention, U. I. 20: namely, tendency to agree, lack of confidence in untried performance, high annoyability, and critical severity. U. I. 20, 24, and 28 are, indeed, consistently "cooperative factors" (2).

Other noteworthy features are the high referral of events to the self, fluency on the self, remembering what one agrees with better than what one does not, low ideational flexibility (M. I. 170), extremity of viewpoint (this *could* be conscientiousness in carrying out instructions), and a slowing of decision time in difficulties. However, if circumstances do not permit him to slow down, the high U. I. 28 person makes more errors than most people (complex reactions, slanting lines, circles). The reader can probably gain personal insight for inferences only by knowledge of the experimental operations of the various tests, but that knowledge fortunately is available through Warburton's *Compendium* [see Cattell and Warburton (14)].

What best ties together many of these phenomena at a descriptive level of explanation is a general asthenia, which can be interpreted further as (*a*) a discouragement and depression or (*b*) a negativistic and internally inhibiting tendency—as seen, extremely, in the catatonic—or (*c*) a sense of unworthiness, as in a person drilled to expect little satisfaction of spontaneous needs or ambitions. It is true that (*b*) is not *conspicuous* in the tests and derives from later clinical observation (12), but "little considered possible in the time," "extremity of viewpoint," "distant goals unattainable," and "many slanting lines crossed in CMS test" (a kind of carelessness) could be considered, at the least, an evasiveness (like dawdling over a job) and, at most, a negativism.

In a first judgment among the foregoing alternatives, we may note that the ordinary "level-of-aspiration" variables do not load the factor, and that measures commonly considered associated with depression (e.g., slow reaction time, pessimism, few jokes considered funny, and small size of myokinetic movements) appear in other factors rather than here. In studying the anxiety factor U. I. 24, Cattell and Scheier (12) came to the conclusion that, in clinical terms, it is "free-floating anxiety" and, in looking for an equivalent for the clinicians' "bound-anxiety" concept, U. I. 20 and 28 (especially the latter) seemed the most probable identifications. This views the loss of energy, the time-perception phenomena, the anxiety-like variables, and the ideational rigidity and sterility in U. I. 28 as consequences of the binding of energy by early anxiety, and the authority pressure alignment as the early cause of the anxiety and its binding.

D. OTHER SOURCES OF EVIDENCE

Pursuing the areas described in the section on methodology above, we note next that there are no *substantial* relations to questionnaire factors (including most forms of overt anxiety); but that a slight, *significant* negative relation exists to ego strength, C, and to superego strength, G, with positive relations to conservatism, lack of self-sufficiency (i.e., to group dependency), and ergic tension. Similarly, in the Guilford-Zimmerman questionnaire significant relations exist with the depression scale and with cooperativeness and objectivity. These relations are consistent with the asthenic picture from the objective tests, suggesting perhaps the remnants of a high anxiety level from some former period and an ensuing caution, lack of drive, depression, dependency, and lack of self-confidence.

The evidence on nature-nurture ratios for U. I. 28 (18) indicates rather more environmental than hereditary determination (approximately 78 per cent) and about three-fifths of this environmental variance lies in differences *between* families, not between children *within* a family. The most likely inference, therefore, is that we are dealing with an influence rooted in family tradition or general parental attitudes and values, conscious or unconscious—not with that kind of environmental effect, traumatic or otherwise, peculiar to one child.

In regard to age trend, data are scanty, but from 9 to 15 years it is one of only two factors that show a definite *decline*. The other is a decline of exuberance, U. I. 21, which is most readily explained as a falling off in basic metabolism, but no such maturational trend in some early constitutional tendency seems to fit the present pattern. Because this is a period when the child is becoming less dependent on the family, the most promising hypothesis seems to be that the effects of some early parental environment is being reduced, though the possibility should also be considered that (even without removal of the external influence by greater distance of the parents) some maturational tendency reduces inhibitory effects.

At this time, five independent second-order factorizations of objective personality factors exist (17), and four contain U. I. 28. They agree in showing it to fall principally into Factor U. I. I, tentatively called "Tied Socialization," or "Super Ego—*vs.*—Absence of Cultural Introjection," containing mainly U. I. 20, U. I. 1(—), U. I. 19(—), and U. I. 25. (There are also lesser loadings on the second orders called Temperamental Apathy [U. I. III(—)] and Absence of Educated Self-Consciousness [U. I. IV(—)]. Note the loading in Table 1 on "absence of knowledge of etiquette." The main conclusion seems to be that formation of this U. I. 28 pattern is favored by whatever contributes to a controlled (U. I. 20), subdued [U. I. 19(—)], reality-accepting (U. I. 25) individual. The psychological consistency of the conclusion from these independent, second-order factorings is high, but it would be speculative as yet to rest on the interpretation that "Tied Socialization" is definitely either (*a*) Superego or (*b*) the totality of family and social influences conducing to moral conformity.

As to *state* factors throwing any light on U. I. 28 there is a tolerable match with P, U. I. 10(—) which has been interpreted (4) as heightened mood of guilt, with lowered skin resistance, higher tendency to agree, higher ergic tension (Q_4), muscle tension, readiness to suffer stronger electric shocks, etc. (4, p. 177). Until this pattern is further confirmed, however, it is more illuminated than illuminating in the present association.

The demands on test time and skill with the O-A Battery (4, 13, 14) are such that only the more research-minded psychologists have begun to obtain criterion data, which data are therefore few. However, the striking finding on two researches comparing a control group with (*a*) a group of typical neurotics and (*b*) a group of sociopathic (possibly also neurotic) individuals with drug addiction, etc., is that the U. I. 28 score is significantly greater than normals for neurotics ($t = 3.06$) and less than normals for sociopaths ($t = 4.03$). Some recent work with criminals (28) again shows U. I. 28 to be below normal ($t = 3.27$). In relation to college grades, a group of 84 studied by Pawlik (26) shows a significant negative relation to achievement ($r = -.19$, $p < .05$). Consistently, Horn's study of 140 undergraduate students shows U. I. 28 to have a highly significant negative relation to social status and educational level of parents (20).

No manipulative experimental evidence on U. I. 28 exists. and the clinical-individual evidence will be taken into the following discussion.

E. INFERENCES AS TO THE NATURE OF U. I. 28

From the various sources one gets a very consistent conclusion that U. I. 28 represents some kind of general inhibition. However, a more simple general inhibition or timidity factor has long been known in the objective-test realm in U. I. 17 (4), as recently discussed intensively by Pawlik (26). The latter *may* be a more temperamental "tendency to *become* inhibited," but certainly U. I. 28 is a state of acquired, internalized inhibition or apathy due to some kind of environmental history.

The inhibition and general restriction of behavior has occurred at some early time and is extinguishing by 8 or 9 years of age; so it seems reasonable to assign its origin to early family experience. Because the environmental variance is largely intrafamilial and is associated with socioeconomic class, we may assume that it is associated with *early* imposition of rigid standards of behavior, such as occurs today more in lower than in upper middle-class homes.

U. I. 28 forms part of the second-order factor, U. I. I, of *Tied Socialization,* to which U. I. 20, Comention, also belongs. But though U. I. 20 has moral-standards content, U. I. 28 does not. The association of low U. I. 28 with delinquency could simply mean that generally poor and insufficient attention to introducing cultural standards prevails in delinquent homes or, alternatively, that the high level of general inhibition imposed at an early age offers a poor soil for development of any kind of delinquent rebellion.

However, by our hypothesis, the pattern of U. I. 28 represents an imposition of standards that in some sense has "gone too far." It might be that if curvilinear relations were investigated we should find that this pattern does not exist over the whole range—in fact not over the range from the delinquent to the normal moral ideal—but that it appears only when this inhibitory pressure passes the "normal" average. Separate factorings over two ranges would show this. But it seems far more likely, and is the hypothesis here adopted, that the pattern arises not from the total cultural inhibitory pressure but from the early age and uncompromising, "unintelligent" way in which it is applied. In this connection, we note that low intelligence is definitely statistically involved with U. I. 28 in the Tied-Socialization factor (16) and this might reflect lower intelligence in the parent. Obviously one must always make a distinction between the desirability of cultural-moral habits and (possibly) undesirable ways of inculcating them. The patterns we call U. I. 20 and U. I. 28, which are correlated in the single second-order factor of Tied Socialization, might represent these two distinct aspects. Our hypothesis for immediate experiment, therefore, is that the quality of psychological stultification in high U. I. 28 arises from too early an application of—and too strong and too strict an application of—disciplined behavior demands (of a general, not just moral, nature) which in themselves may be appropriate and desirable in the long run. However, let us be clear that these are standards of "not doing anything to displease the parents," and which do *not* include achievement—for the families of high U. I. 28 individuals are low achievers. The lack of spontaneity, the general asthenia and lack of drive, the mild depression, anxiety, and ego weakness, the dependence on group standards, and thoroughly socially oriented inhibitions of the high U. I. 28 individual are to be regarded, on this hypothesis, as the outcome of early denial of self-expression. In psychoanalytic terms, it might be regarded as a defective ego development, partly through too emphatic an early superego demand.

Obviously this imposition could not have taken place without some adequate degree of affectional bond between parent and child (psychoanalytically, an oedipal attachment). Without such an affectional need to introject the parent, the child would "go right outside the field" when the dynamic losses exceeded the gains of staying in it. But delinquency, such as is known to increase with total rejection of the child, with hostility and lack of affection, is positively absent here. Of course, if the period of action were very early—say at 2 and 3 years—the child is so completely in the power of the parent that its acceptance of the imposed standards could come through many drives (e.g., hunger and fear) other than affectional ones.

In clinical terms, an examination of two or three high U. I. 28 individuals *does* show some ambivalence to authority. In these individuals, authority is sometimes a subject of obsessional questioning at the intellectual level, while being accepted like a comfortable shoe in practice. Another sign we have seen of possible ambivalence is a sort of dawdling over tasks. These individuals carry out tasks with predictable responsibility, but slowly and with apparent unnecessary expenditure of time and ceremony, "as if" under an unspoken protest. These individuals, incidentally, appear very strict with their own children, and particularly in the sense of clearly expecting rational and unselfish behavior at as early as 2 or 3 years of age.

Nevertheless, both from these observations (which admittedly could suffer from the "clinical fallacy" of no comparable intensive study of low U. I. 28 controls) and from the broader experimental response and home-background scores, we conclude that the strictness is not primarily an expression of aggression or rejection emanating from the parent's *personality,* but an expression of traditional values taken up in the adoption of the parental *role.* The distinction between behavior due to personality and that due to role has often been made verbally, but only recently has it been expressed in a definite model (5) which will permit the issue of origin to be put to an experimental analysis. Our hypothesis is that although an aggressive role does, of course, give opportunity for expression of personal aggressiveness, yet there is in these cases no primary pugnacity against the child as such, but only repressive treatment through the dynamic adoption of this particular aggressive parent role which occurs as part of the formation of a respectable self-sentiment. Only thus, in the child's unconscious distinction of personal and impersonal aggression, can one explain the acceptance of—indeed, the abiding quiet enthusiasm for—authority and social approval shown by these children.

This hypothesis fits better, by far, the majority of facts than others we have tried. If it does not seem immediately to explain sufficiently the full extent of the asthenia and poor capacity to achieve and perform vigorously, one must point out that the hypothesis implies considerable early internal conflicts and an extensive practice of repression which, in clinical terms, would result in much tying up of mental energy and a high *bound-anxiety* level. Indeed, Scheier (13) has pointed out that U. I. 28 is the nearest experimentally, psychometrically-real pattern discoverable to the clinician's description of bound anxiety.

The only evidence that perhaps does not immediately fit the hypothesis lies in the nature of certain behavioral measures in the factor "content." In terms of *omissions* one might have expected aspiration level measures (M. I. 101), highbrow tastes (M. I. 117), speed of decision (M. I. 153), absence of questionable reading preferences (M. I. 21) and high index of carefulness (M. I. 51), and possibly high critical hostility of judgment (M. I. 116), freedom from cheating (M. I. 16), high rigidity (M. I. 2) and low optimism (M. I. 100) to have appeared in this pattern. Their absence indicates that the socioeducation standard itself is not central, and that it is not high standards but a manner of strictness that is important.

In terms of variables unexpectedly *present*, the main problem is explaining the substantial concern with poor time estimation and the higher ratio of working to resting time. A simple "dynamic" explanation is that some negativistic aversion to work (to imposed standards) causes work time to seem unduly long. But, for reasons not yet clear, it is more likely that some broader upset of time sense is involved. The most likely explanation is that it arises directly from general "anergia" (lack of drive). For if we assume that sense of time is bound to an internal dynamic flow, in this case, obviously defective through the general asthenia, it would be faulty. (Sleep abolishes the conscious time sense and presumably being half asleep makes it less reliable.)

F. Discussion on Further Experiment

In the earlier literature, the terms used to describe U. I. 28 have been "asthenia" (4), "sociable emotional evasiveness" (3, 10, 16), and "rigid super ego" (13). The second derives from the earliest appearance of the pattern, when the contrast between the social-convention orientation and a certain emotional ego weakness and evasion first struck the researchers. Asthenia, in the sense of something heightened in the clinical picture of neurasthenia, and the opposite of various descriptions of the "sthenic" temperament (1) is still entirely acceptable as a good *descriptive* term.

However, the advance of research should lead to interpretation as well as to description. The "rigid super ego" was a step in the right direction, but the fresh evidence and reasoning here show that this is both too much (in taking over a ready-made psychoanalytic concept with elaborate theoretical connections) and too little (in that it does not express the inappropriate early imposition of inhibitions). A new name is needed which can be quite specific to U. I. 28 (and avoid mere index numbers for those who prefer words), while expressing the hypothesis. No brief Greek derivative can express the complex relation here required so we have taken refuge in an acronym—*apnicia*—from *asthenia* through *premature inhibition* by *cultural* demands. The opposite pole to this apnicious extreme would be *surellia*, similarly an acronym from *sthenia*, through *unrepressive rearing* in *early life*. The surellious individual, at the pole of the factor we have hitherto not much dwelt upon, has a rough energy, is inclined to delinquency, and antiauthority behavior, and is an active achiever along his own lines.

This hypothesis, now stated in *apnicia*-vs.-*surellia* contains three main aspects (asthenia, early overdiscipline, and authority-realism with dependence), indicated the need for further research as follows:

1. Objective measures of actual work output and achievement relative to intelligence of individuals high on apnicia scores.
2. Measurements of U. I. 28 on children (since the factor has been found for 8-to-12-year-olds) correlating with social worker and parental attitude-measurement evaluation of strictness and extent of control, particularly in the few preceding years.
3. Measurements of apnicia on children who change from one home to another, as well as more precise determination of the age trend for children in general in relation to their movement from a home to a peer-centered group.
4. Studies of delinquents to determine the extent and form of the relation of delinquency to low U. I. 28 scores: i.e., to surellia.
5. Cross-cultural comparisons of adult or child U. I. 28 scores. For if the hypothesis of the major role of early strictness of upbringing is correct, substantial relations should be found to observations of cultural anthropologists.

These are new directions of research, but there is also much to be done in sheer checking and refining of primary concepts. For example, to what extent is honesty and ethical behavior generally also in the picture along with the respect and concern for authority? And what is the answer to the riddle of the curious "cooperativeness" in factor pattern of this factor with Comention, U. I. 20, and Anxiety, U. I. 24?

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THE EFFECTS OF BLOCKING THE CONSUMMATORY RESPONSE ON THE ACQUISITION AND PERFORMANCE OF AN ASSOCIATED INSTRUMENTAL RESPONSE*[1]

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A. INTRODUCTION

The present study was designed to test the hypothesis that blocking a consummatory response under a high-deprivation condition can produce a subsequent decrement in the performance of an immediately preceding instrumental response. This hypothesis resulted from a comparison of data in two investigations of food hoarding in rats: hungry animals whose food pellets were immediately removed upon their return to the home cage showed negligible hoarding when subsequently tested under ad libitum feeding conditions, whereas animals whose pellets were similarly removed while they were on an ad libitum feeding schedule showed normal hoarding behavior on the subsequent test (11, 13; *cf.* also 12).

To examine this response-decrement hypothesis, the blocking condition was imposed upon the classical design for the testing of the effects of deprivation level upon learning. Two levels of deprivation in training were combined factorially with two levels of deprivation at test.

In addition to its test of the specific response-decrement hypothesis, this experimental design was to provide empirical information on the more general problem of learning and performance as functions of drive level. Research on the relationship between drive level at training and resistance to extinction have given equivocal results. Several studies (e.g., 15, 17, 18) have failed to show a relationship between hours of deprivation during training and resistance to extinction. On the other hand, some studies (e.g., 3, 10) have shown statistically reliable but relatively small effects.

B. METHOD

1. *Subjects*

The *S*s were 78 naive 90 to 110-day-old albino rats from the University of Missouri colony. Fourteen of these rats were discarded for illness or for

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failure to meet the criterion of conditioning. Eight rats in each of eight groups completed the experiment.

2. *Apparatus*

Four Skinner boxes employing Gerbrands' pellet magazines and P. J. Noyes' 45-mg pellets were used. The food dish was arranged so that if a pellet was not consumed within three seconds it was rotated out of *S*'s reach.

A Gerbrands' bar, located three and one-half inches above the food dish and requiring approximately 22-gms pressure to operate, was employed. The food dish was located on the floor of a Hoeltge HB-11A cage of the same sort as that used to house the animal. Access to the food dish could be blocked by a hardware-cloth screen. These assemblies were located in a battery of four sound-deadened, light-tight, dimly illuminated, ventilated icebox hulls.

3. *Experimental Design*

Two levels of deprivation during magazine training and barpress (BP) acquisition were combined factorially with two levels of deprivation at time of extinction and a block *vs.* no-block procedure in BP acquisition. Half of the *S*s were trained on a high-deprivation schedule (H) and half on a low (L). These two sets were split at the time of test. Half remained on their original training deprivation. The other half shifted to the other deprivation condition. Half of the *S*s in each of these four deprivation groups were run on the no-block procedure and half on the block procedure in BP acquisition.

4. *Procedure*

a. Deprivation schedules. A 22 and three-quarter hour deprivation schedule was used for all animals. The H *S*s were fed for one hour and 15 minutes immediately after an experimental session. The L *S*s were fed for 15 minutes immediately after running and for one hour, four hours before an experimental session. Thus the H *S*s had not eaten for 22 hours and 15 minutes before running, and the L *S*s had not eaten for four hours. *S*s were placed on this schedule five days before running. Following training, *S*s were shifted to their new deprivation condition for four days and then were tested.

b. Magazine training. All *S*s received six days of magazine training, consisting of 23 operations of the magazine on a variable-interval schedule in a 30-minute period. The pellets not consumed in three seconds were automatically removed from the food dish, as described earlier, and were later counted by *E*.

c. Barpress training. In the first cycle, *S*s received one day of BP training.

For blocked *S*s, the food dish was covered with hardware-cloth and the pellet was not available. Nonblocked *S*s found the pellet available. The magazine operated in all cases on a one-minute variable-interval schedule. Any rat which did not make at least 10 BPs in the first BP session was discarded.

In the second cycle, following a period of ad libitum feeding, the animals were returned to their original schedule and were given, first, one day of magazine training; then, six days of reinforced BP training. One further day of barpressing was given with the same *S*s again being blocked.

d. Extinction test. Twelve days of extinction followed BP training after four days of accommodation to the new feeding schedule in both cycles.

C. RESULTS

1. *Cycle 1*

The basic data are given in Table 1, which shows the antilog mean logs of all BP measures for each group.

TABLE 1
TRAINING AND EXTINCTION ANTILOG-MEAN-LOG BARPRESSES IN CYCLE 1

Training deprivation	Mean number Missed pellets	BPs	Extinction BPs First five minutes	First day	Total	Days to extinction criterion
			Extinction Deprivation H			
No Block H	19.3	168.6	31.8	97.7	306.0	6.1
No Block L	20.6	118.6	18.3	71.5	232.0	5.6
Block H	40.2	62.0	10.0	32.7	148.8	3.8
Block L	23.9	43.3	9.0	23.3	159.9	4.0
			Extinction Deprivation L			
No Block H	18.1	172.3	19.9	75.3	243.0	5.5
No Block L	28.2	79.6	15.1	56.6	184.0	3.9
Block H	16.7	42.8	6.4	27.0	157.4	3.2
Block L	25.6	43.3	8.3	31.4	173.0	3.8

a. Magazine training. An analysis of the number of missed pellets shows only the training-deprivation variable approaching reliability ($p > .05, F = 3.55$, for 1 and 56 *df*). Out of the 138 pellets delivered, the L group missed a mean of 26.5 and the H group 21.4.

b. Barpress training. An analysis on the log number of BPs over training deprivation, extinction deprivation, and block-no-block, shows that there are reliably fewer in the blocked group (47.3 *vs.* 128.7; $p < .01$, $F = 36.62$, $df = 1, 56$) and reliably fewer in the L group (64.8 *vs.* 93.8; $p < .05$, $F = 4.95$, $df = 1, 56$). As would be expected, neither the main effect of test deprivation nor any of the interactions approached reliability.

c. Extinction test. An analysis of variance on the log number of responses in the first five minutes of extinction on the first day of extinction over training deprivation, extinction deprivation, and block-no-block shows only the block variable reliable ($p < .01$, $F = 21.46$, $df = 1, 56$), the greater number of responses occurring in the no-block condition (20.5 *vs.* 8.3). However, an analysis of covariance using the log number of BPs during the training session as the control variable eliminates this reliability.

An analysis of variance on the log number of responses on the first day of extinction over the same variables shows only that there are reliably fewer responses in the blocked group (28.3 *vs.* 73.9; $p < .01$, $F = 28.50$, $df = 1, 56$). An analysis of covariance on these data using the log number of barpresses in the training barpress session as the control variable shows no reliable differences. That is, again the effect of the block condition in extinction can be attributed to the number of responses made during training.

An analysis of variance similar to the one above on the log total number of responses in extinction again shows the block condition producing fewer total number of responses (159.3 *vs.* 237.5; $p < .01$, $F = 7.43$, $df = 1, 56$), but again the covariance analysis removes this reliability.

An analysis similar to the above on the log number of days to 10 or less responses again shows that blocking produces reliably lower scores (3.8 *vs.* 5.3 days; $p < .01$, $F = 6.49$, $df = 1, 56$). Again the analysis of covariance removes this significance.

In summary, the deprivation at time of BP training as well as the occurrence of primary reinforcement affects the number of responses made during training. Neither the training deprivation nor the extinction deprivation affects the number of responses or the time to criterion in extinction. The differences in number of responses and time to criterion in extinction resulting from the block condition in training can be attributed to the number of responses made at the time of training. There appear to be no residual effects.

2. *Cycle 2*

The data are provided in Table 2.

a. Barpress training. An analysis of the mean number of BPs over the six training days shows only training deprivation to have been reliable ($p < .01$, $F = 8.74$, $df = 1, 56$). The H group exceeds the L group (294.7 *vs.* 179.2) and the no-block group exceeds the block group (267.8 *vs.* 162.3).

Consider now the single reinforced BP session, in which access to the magazine was blocked; both the training deprivation ($p < .01$, $F = 27.04$, $df = 1, 56$) and the block-no-block condition ($p < .01$, $F = 9.90$, $df = 1$,

TABLE 2
TRAINING AND EXTINCTION ANTILOG-MEAN-LOG BARPRESSES IN CYCLE 2

Training deprivation	Mean number training BPs	Extinction BPs			Days to extinction criterion
		First five minutes	First day	Total	
		Extinction Deprivation H			
No Block H	270.0	274.5	137.3	596.8	10.7
No Block L	242.0	252.0	159.6	607.7	8.8
Block H	258.0	201.5	93.1	438.6	9.7
Block L	180.0	150.0	113.2	436.0	9.0
		Extinction Deprivation L			
No Block H	355.6	342.1	156.2	590.1	8.7
No Block L	215.7	217.5	116.6	468.8	9.9
Block H	261.6	183.0	84.0	357.1	8.2
Block L	208.5	125.5	76.7	354.0	8.6

56) give reliable differences. The H group exceeds the L group (242.6 *vs.* 179.2) and the no-block group exceeds the block group (267.8 *vs.* 162.3).

b. Extinction test. Analysis of log number of responses on the first day of extinction shows the no-block condition reliably superior to the block condition (141.4 *vs.* 91.0; $p < .01$, $F = 19.71$, $df = 1, 56$). Both the main effect of training deprivation and the interaction of the training and extinction deprivation approach the .05 level.

An analysis of covariance, using the log number of barpresses in training, finds the block-no-block variable nonreliable, but raises the training-deprivation variable to reliability ($p < .05$, $F = 5.63$, $df = 1, 55$). The corrected H group mean exceeds the L group mean (125.1 *vs.* 102.8).

An analysis of the total number of responses over the twelve extinction sessions shows the no-block condition reliably exceeding the block condition (562.9 *vs.* 394.3; $p < .01$, $F = 10.46$, $df = 1, 56$). Analysis of covariance again removes this reliability. An analysis of the log number of days to 10 or less responses reveals no reliable differences. Covariance does not change this result.

D. DISCUSSION

The effects of blocking the consummatory response in the present experiment are of interest mainly in two ways. First, there seem to be no residual (nonassociative) effects resulting from the blocking. The differences in subsequent extinction performance appear to be completely accounted for by the terminal level of responding in the reinforced-performance phase. Thus the hypothesis that blocking would more effectively depress subsequent responding if the animals were more severely deprived when blocked was not confirmed. However, it should be noted that the present experiment does not constitute a critical test of the hypothesis relating blocking at acquisition and subsequent performance as a function of original drive level. Such a test needs to be conducted with experimental control of the number of responses presented in acquisition.

Second, the results suggest two sources of the relationships between the deprivation at the time of training (following sufficient training) and the subsequent nonreinforced performance. The first source is the correlation between successive samples of performance regardless of how the performance differences are produced (by primary *vs.* secondary reinforcement, differing magnitude of reinforcement, differing deprivation levels, etc.). For example, Hutt (7) has shown a correlation of .90 between log rate and log number of responses in extinction, while varying taste; Jenkins, McFann, and Clayton (8) report correlations of .95 and .98, while varying interval between reinforcements. This relation appears mainly in the early stages of extinction (1, 3, 10). These results suggest a simple proportionality relation between the rate and total number of responses and the terminal rate of responding preceding the shift in deprivation or reinforcement conditions.

The second source is the shift in deprivation from training to test. The accounts of Estes (6) and of Yamaguchi (19) of the shift effects are based on stimulus overlap or stimulus generalization and predict that the shift down in deprivation will produce a smaller decrement in performance than the increment produced by the shift up. Such findings are reported by Yamaguchi (19), Deese and Carpenter (5), Davis (4), and Barry (1).

The present data also have implications for frustration theory. There was no increment in responding immediately following blocking in either Cycle 1 or Cycle 2 of the present experiment. It is not clear that any increment in responding would have been expected in Cycle 1 because the BP response was being acquired at the same time that the magazine response was blocked. This may have produced a competition between responses such that frustration-produced increments in drive may not have been reflected in the weakly learned BP response. However, it seems clear that there should have been some increment in rate in Cycle 2, during which cycle the BP response was well learned. No reliable increments or decrements occur in either case. At the present state of theorizing about frustration, it can be argued that competitive effects and drive effects cancel in any given case or that the particular blocking operation used was ineffectual in producing frustration. It seems more parsimonious, however, simply *not* to introduce frustration as a concept with presumed nonassociative effects until the need for such a concept can be shown. The present experiment shows no such need. The results are consistent with the position that the effects of frustration are purely associative; so they require no special mechanism, at least insofar as increased vigor is concerned (*cf.* 9, 12).

As has previously been reported (2), the results show that both reinforced and secondarily reinforced barpressing are sensitive to current level of deprivation. The pellet-associated operation of the magazine produced an increment in responding above that expected for the presentation of the bar alone or for a light or tone contingency, which contingency usually averages about 25 to 30 BPs in a session of 30 minutes on the first day in this apparatus (*cf.* 14, 16). The effect of the deprivation difference is less on the secondarily reinforced responses than on the reinforced responses. The difference that does exist is apparently not the result of differential strength of response to the magazine because there are no significant differences in the numbers of missed pellets. In the second cycle, during which the secondarily reinforced responding followed a series of reinforced magazine sessions and may be regarded as a form of extinction, the decrement in responding is less than that produced by nonreinforcement and is sensitive to the level of deprivation. The L group shows the greatest relative decline.

E. Summary

Two levels of training deprivation, two levels of extinction deprivation, and a block *vs.* no-block condition in training were combined factorially in an examination of the effects of blocking the consummatory response during training on subsequent instrumental performance. Eight rats were used in each of eight groups. There were two complete cycles of training and extinction.

Both blocking of the consummatory response and level-of-training deprivation affected subsequent instrumental performance. However, these effects appear to be determined by the prior level of performance and, in the present experiment, do not require an appeal to nonassociative factors.

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PRENATAL MATERNAL ANXIETY AND OFFSPRING BEHAVIOR: PARENTAL ACTIVITY AND LEVEL OF ANXIETY*[1]

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A. INTRODUCTION

During the last 20 years, it has been demonstrated that a wide variety of agents administered to female animals during pregnancy can produce an equally wide variety of morphological and physiological changes in the offspring (4). More recently, a number of investigators, using stressing agents, such as x-irradiation, anoxia, alcohol, intense sound, and various chemical compounds have been able to demonstrate behavioral changes in offspring of treated mothers. Such dimensions as learning ability, emotionality, seizure susceptibility, and motivation have been found to be affected [see (6)]. The senior author (5, 7) and several others, in particular Doyle and Yule (2), Hockman (3), and Ader and Belfer (1), have recently obtained evidence that so-called psychological pregnancy-stress, as produced in a conditioned-avoidance situation, may also have effects on offspring behavior.

It is the purpose of this study to explore more fully these effects of pregnancy-anxiety and to examine the contribution to such effects of two important parameters: namely, parental activity level and amount of anxiety.

B. METHOD

1. *Subjects*

Twenty Sherman albino females and 20 males were tested at 100 days of age in an open field on three successive days. On the basis of their scores, *S*s were divided into high-, medium-, and low-active groups. Matings were made within each of these groups. Each of these groups was further subdivided randomly into three subgroups receiving high pregnancy-anxiety (HA), low pregnancy-anxiety (LA), or neither [control (C)]. HA and LA groups were treated differentially in terms of number of avoidance-training and test

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trials and strength of shock used in training. Details are described later. Out of all offspring born, 72 were tested, with four males and four females from parents having a particular combination of variables: e.g., high anxiety, low activity, etc. In all but one of the nine combinations in the design, at least two litters were represented. Cross-fostering between experimental and control offspring was carried out within three days of birth.

2. *Apparatus*

a. Avoidance-conditioning apparatus. This was used for producing pregnancy-anxiety in the mothers. It consisted of a double compartment box 6″ × 6″ × 18″ with hinged lid, the two sides being separated by a panel on a spring. This panel was held shut by a latch that could be released by light pressure applied to a lever. The shock side was painted black and contained a grid floor through which a D. C. shock could be delivered. A buzzer was set at the top of this compartment close to the center panel. Shock was given by means of a commercial D. C. electronic stimulator. The nonshock side was painted white and had a wooden floor.

b. Open-field test. This consisted of an open enclosure 42″ × 30″ with walls 9″ high and dimly lighted by an overhead 40-watt bulb shielded by a cheesecloth screen. Ambulation was measured by means of a grid formed of 20 squares and by photocells and light sources set in the walls of the field. When the movement of *S* broke a beam, there resulted a change in voltage that activated a resetable Veeder-Root counter in an adjoining room. At the start of testing, *S*s were placed gently in a corner of the field. Three 10-minute trials were given on three successive days for each of two testing conditions. The two conditions of testing were a so-called normal or nonstress condition and a stress condition. The stress condition involved administration prior to introduction to the open field of 12 two ma shocks given one every 10 seconds.

c. Runway test. This consisted of a runway 36″ × 6½″ with walls 8″ high, leading out from a standard living cage. A dish of wet mash was placed at the other end of the alley and *S*s were run under 23-hour food deprivation. A record was made of the time taken by an *S* to leave the home cage, to reach the middle of the alley, and to reach the goal box. A maximum time of 20 minutes was allowed.

d. Water maze. A rectangular, three-cul wooden maze was set in a child's plastic wading pool. The floor plan is shown in Figure 1. Culs are marked by the dashed lines. The long alleys were 42″ long and 6″ wide. The starting box

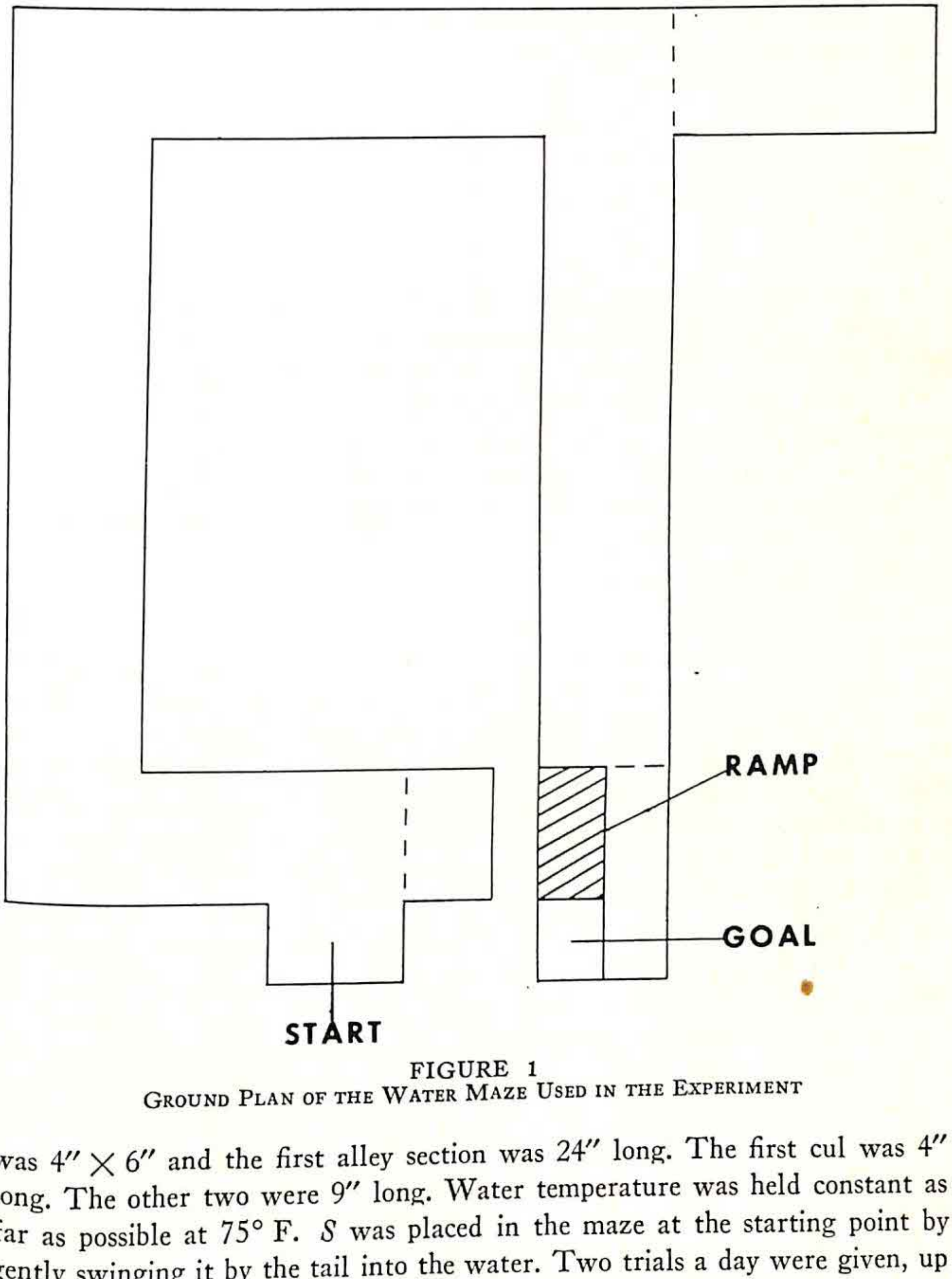

FIGURE 1
GROUND PLAN OF THE WATER MAZE USED IN THE EXPERIMENT

was 4″ × 6″ and the first alley section was 24″ long. The first cul was 4″ long. The other two were 9″ long. Water temperature was held constant as far as possible at 75° F. *S* was placed in the maze at the starting point by gently swinging it by the tail into the water. Two trials a day were given, up to a criterion of two errorless runs. Maximum time allowed for any one trial was five minutes. Scores recorded were number of trials to criterion, errors per trial, and time per trial. Tests were given in the order listed, with an interval of 3 to 4 days between each.

3. *Procedure*

a. Prepregnancy-avoidance training. Prior to mating, experimental mothers were trained in a double-compartment apparatus to avoid a two-second shock, signaled by a two-second buzzer, by opening a door between compartments and running to the nonshock side. Training procedure consisted of several phases as follows: *Day 1.* Door between compartments locked. Three two-minute trials of 12 shock and buzzer presentations, one every 10 seconds, with one hour between trials. *Day 2.* Door between compartments open. Two trials an hour apart, each trial consisting of five escape responses from buzzer and shock. *Day 3.* Door closed, lever available. Buzzer and shock given every 10 seconds until correct avoidance response made. One successful avoidance constituted one trial. Ten such trials were given consecutively to each animal, on a single day. Procedure during the first three days was identical for HA and LA groups, except that the HA group was trained with five ma D. C. shock, the LA group with one ma D. C. shock. *Days 4 to 17.* During the next two weeks, for the HA group, procedure was as follows: three daily two-minute trials, one hour apart, each trial consisting of 12 buzzer presentations every 10 seconds with five ma shock given when the animal did not make avoidance response. For the LA group, this phase of training consisted of a single two-minute trial of 12 buzzer presentations given daily for one week only. Shock level was set at one ma D. C., again being given only on failure to make the avoidance response.

b. Mating. Control and experimental animals were mated at the end of the training period. Pregnancy was determined by means of presence of sperm in vaginal smears.

c. Pregnancy-anxiety trials. The HA *S*s were given two daily trials, one hour apart, of 12 buzzer presentations every 10 seconds. The instrumental response could be made, but it opened the door only on every third trial. This was done to prevent extinction of the conditioned-anxiety response. A five-ma shock was given occasionally to *S*s which showed no signs of avoidance. LA *S*s received the same treatment, but only on every third day during pregnancy, again with an occasional shock set at one ma.

d. Maternal-activity testing. To obtain an index of the effects on mothers of the two levels of pregnancy-anxiety, all experimental and control females were tested on the open-field test at the following four times: before the start of avoidance training, at mating, during the middle of gestation, after parturition. Each test consisted of three daily 10-minute trials during which activity level was recorded.

e. Offspring testing. Starting at 90 days of age, the 72 offspring of experimental and control mothers were tested on the open field under nonstress and stress conditions, on the runway, and on the water-maze.

C. Results

1. *Maternal Behavior*

The activity levels of mothers from the three groups (HA, LA, and C) are shown in Figure 2. It is clear that the effects of anxiety training are greater in the HA group than in the LA group. And both show considerably lower activity level at parturition than do *C* females. The interaction (trials

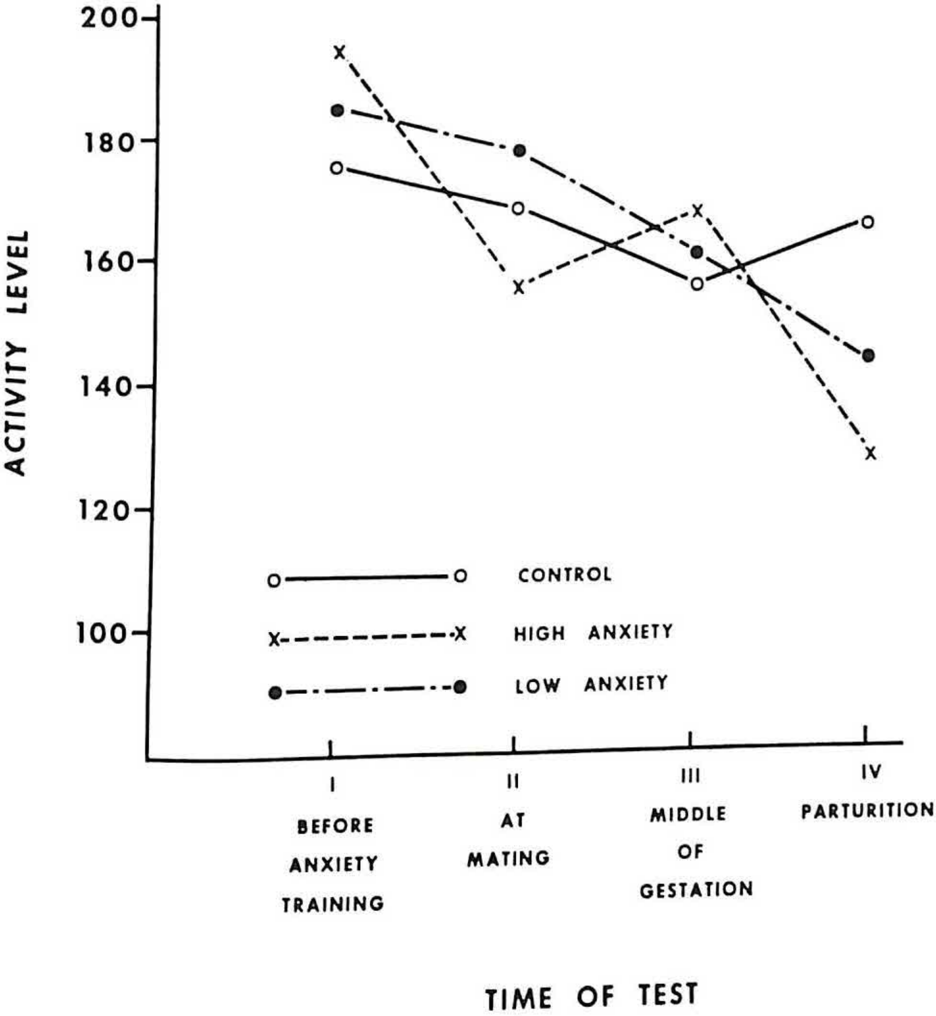

FIGURE 2
Activity Level of Females Undergoing High or Low Anxiety as Compared To Untreated Control Females

× treatment) is in fact significant ($F = 5.78$, $p < .001$). Figure 3 shows the effects of anxiety training on total activity level of initially high-active, medium-active, and low-active groups. Stress slightly increases activity level in the high-active and medium-active groups, but reduces it in the initially low-active group. Again, interaction is statistically significant ($F = 24.92$, $p < .001$). These results show that stress can have bi-directional effects on the activity of the adult animal.

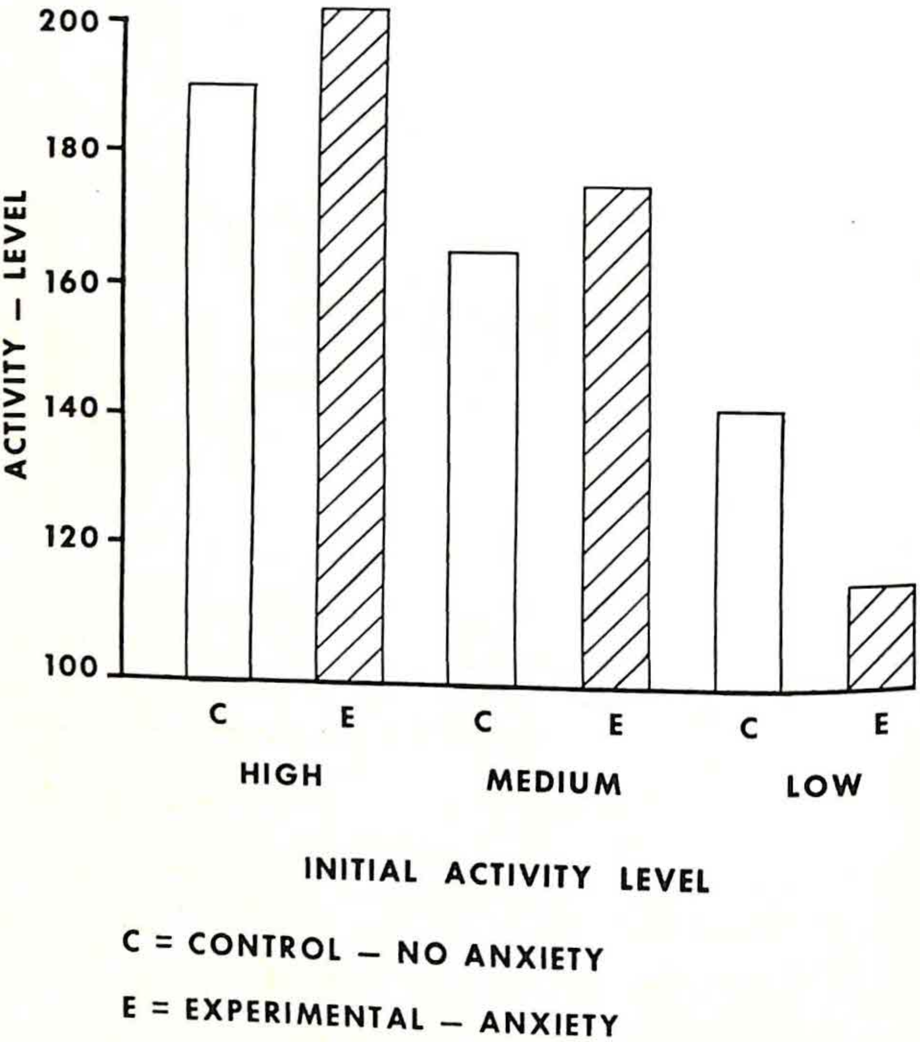

FIGURE 3
Activity Level of Initially High-, Medium-, and Low-Active Mothers in Response To Anxiety Over a Five-Week Period

2. *Offspring Behavior*

The effects of maternal stress on offspring behavior during pregnancy will be considered for each test separately.

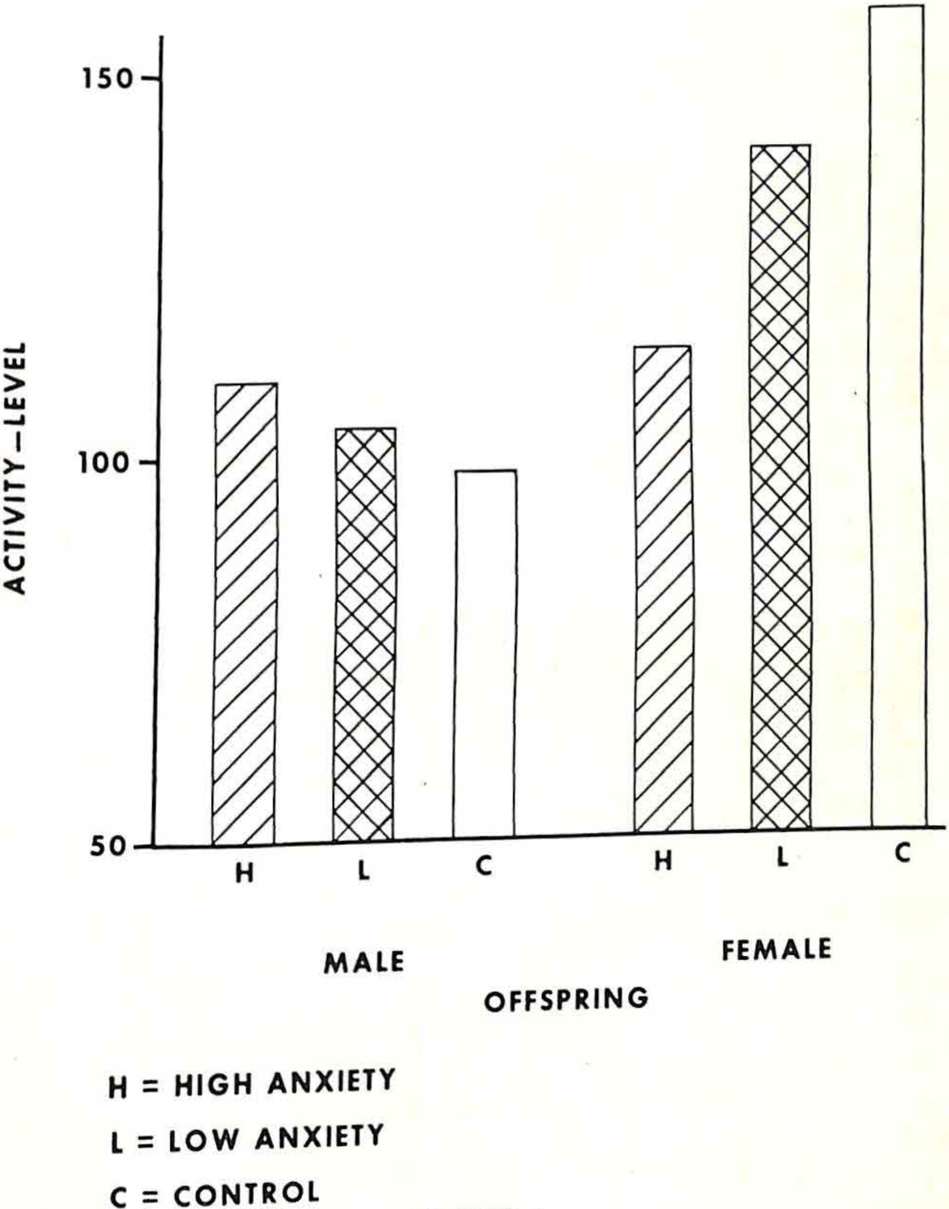

FIGURE 4

Activity Level of Control and Experimental Offspring, Normal Condition
Interaction of Intensity of Pregnancy-Stress and Sex

a. Open-field activity, normal condition. As shown in Figure 4, female experimental offspring show significantly lower activity than do female control offspring. Male experimental animals, however, have about the same scores as do male controls. The interaction (sex × treatment) is significant ($F = 9.52$, $p < .01$). A significant interaction is also found between sex, parental activity level, and treatment ($F = 2.83$, $p < .05$)—as shown in Table 1—but this interaction is too complex to be readily interpreted.

TABLE 1
OFFSPRING OPEN-FIELD ACTIVITY LEVEL AS A FUNCTION OF SEX, PARENTAL ACTIVITY, AND PRENATAL TREATMENT: NORMAL CONDITION

Prenatal treatment group	Parental activity					
	Male			Female		
	High	Medium	Low	High	Medium	Low
High Anxiety	127.6	126.0	72.4	133.5	81.1	119.7
Low Anxiety	115.6	93.6	105.7	148.9	147.2	114.7
Control	113.0	71.1	112.1	170.2	143.4	160.2

b. Open-field activity, stress condition. The main results of this measure are shown in Figure 5 and in Table 2. In general, maternal stress lowers activity level in offspring in proportion to the amount given ($F = 3.85$, $p < .05$). However, again, as indicated in Table 2, this effect is confined mainly to female *S*s ($F = 9.52$, $p < .01$). Table 2 shows, also, that the effect is least in offspring from medium-active parents. This interaction is significant ($F = 2.89$, $p < .05$).

c. Runway latencies. The general result of treatment is to increase runway latencies in experimental animals as compared with controls. See Figure 6. This trend, however, is confined to male animals. Table 3 shows that female controls have higher latencies than female experimental animals ($F = 9.27$, $p < .01$). A significant triple-interaction effect between runway section, parental activity level, and treatment ($F = 3.36$, $p < .05$) can also be seen (from Table 3 and Figure 6). Primarily, this indicates that the most ambiguous effects occur in respect to the offspring from medium-active parents. Control *S*s from this group show higher latencies than do control *S*s from high- or low-active parents.

d. Water-maze test. Only time scores are found to be effected by the experimental treatment. As Figure 7 shows, experimental offspring run faster than do those of controls ($F = 6.12$, $p < .01$), though the HA group from medium-active parents is an exception to this trend ($F = 2.95$, $p < .05$). In all cases, LA offspring are more affected than HA offspring.

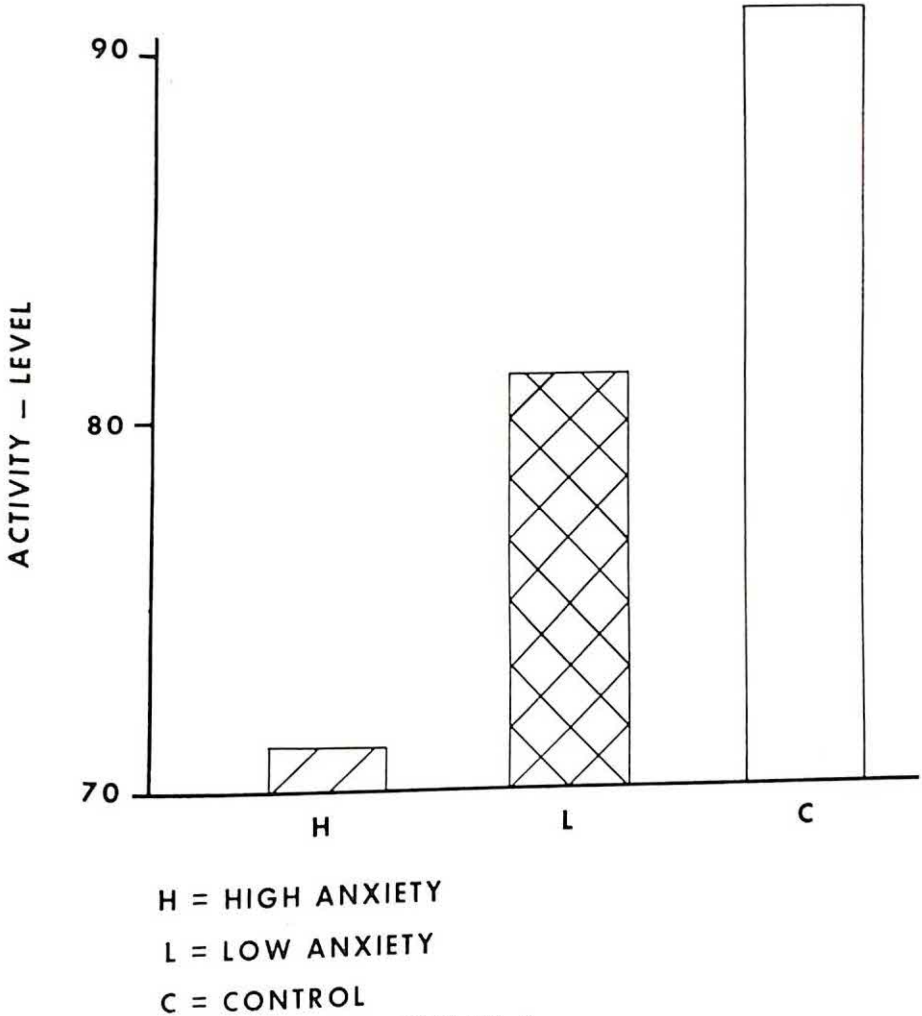

FIGURE 5
Activity Level of Control and Experimental Offspring—Stress Condition
Two Intensities of Maternal Anxiety During Pregnancy

TABLE 2
Offspring, Open-Field Activity Level as a Function of Sex,
Parental Activity, and Prenatal Treatment: Stress Condition

Prenatal treatment group	Parental activity					
	Male			Female		
	High	Medium	Low	High	Medium	Low
High anxiety	88.0	55.1	50.5	105.5	82.9	44.6
Low anxiety	70.8	33.2	18.2	158.8	112.9	96.3
Control	88.4	32.3	48.0	175.6	80.7	151.9

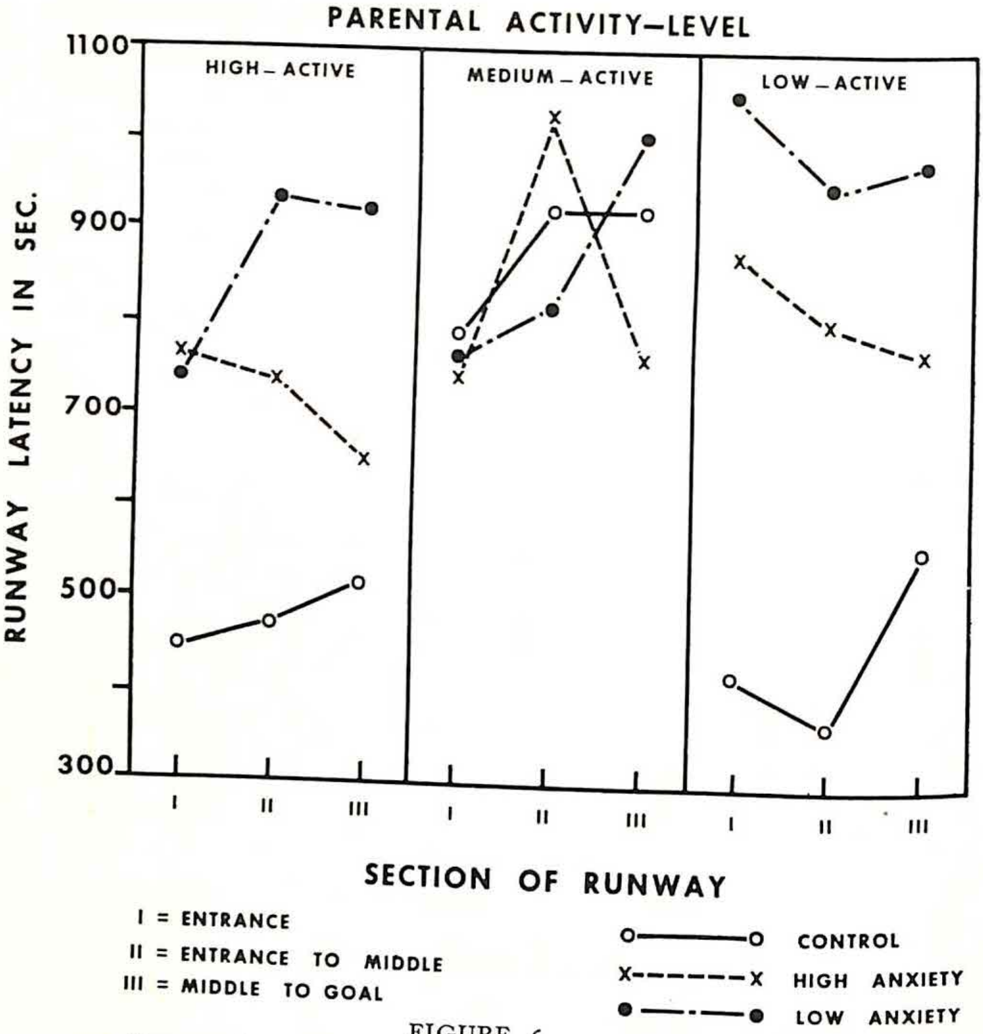

FIGURE 6
RUNWAY LATENCIES OF CONTROL AND EXPERIMENTAL OFFSPRING
INTERACTION OF INTENSITIES OF PREGNANCY-STRESS, PARENTAL ACTIVITY LEVEL AND RUNWAY SECTION

TABLE 3
OFFSPRING RUNWAY LATENCIES AS A FUNCTION OF SEX, PARENTAL ACTIVITY, AND PRENATAL TREATMENT

Prenatal treatment group	Parental activity					
	Male			Female		
	High	Medium	Low	High	Medium	Low
High anxiety	1122.1	730.8	941.7	289.0	895.3	690.8
Low anxiety	1065.2	1200.0	1200.0	629.7	418.9	629.2
Control	349.3	638.2	71.1	619.4	1068.1	841.1

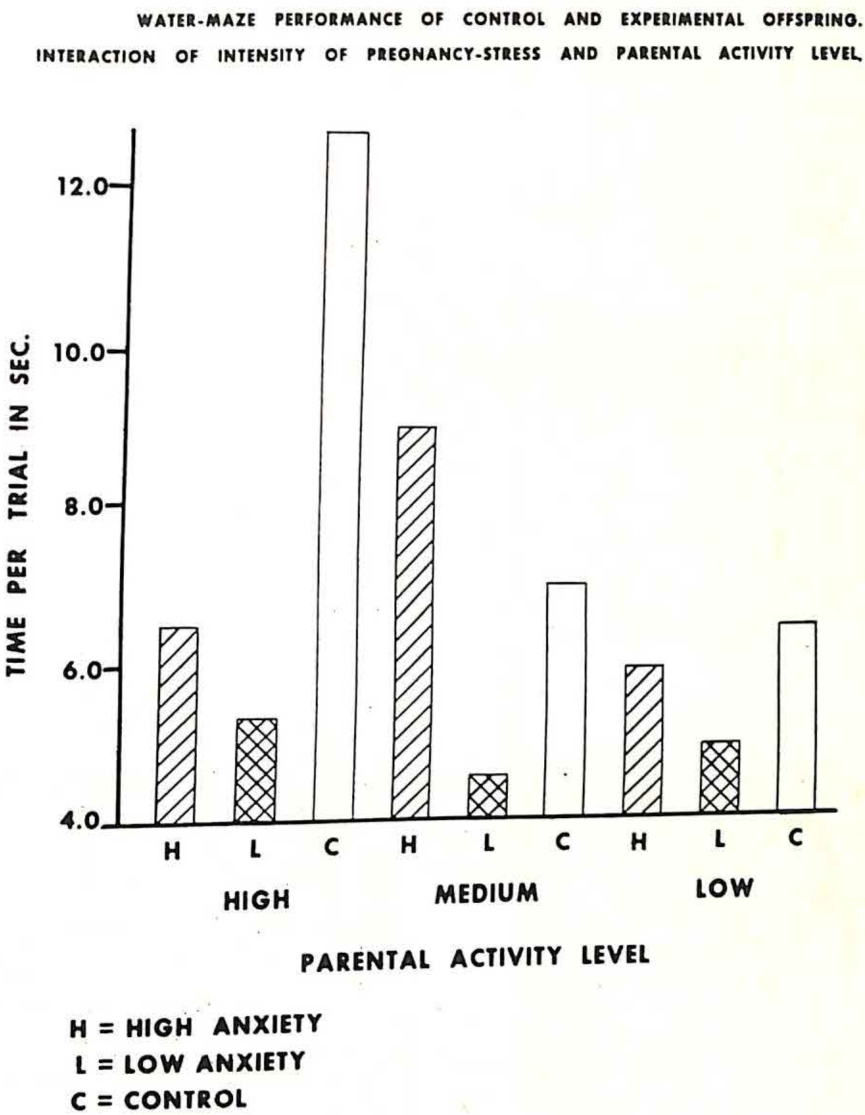

FIGURE 7
WATER-MAZE PERFORMANCE OF CONTROL AND EXPERIMENTAL OFFSPRING
INTERACTION OF INTENSITY OF PREGNANCY-STRESS AND PARENTAL ACTIVITY LEVEL

In none of the tests was any major effect of cross-fostering found. However, this is not to say that interactional effects of the type reported by Hockman (3) might not have been present. Due to the complexity of the design used, we did not test for these, but only for simple, first-order effects.

D. Discussion

The results indicate that offspring-behavior characteristics can be altered by anxiety to which the mother is subjected during pregnancy. In general, changes are in the direction of increased emotionality as indicated by depression of open-field activity, by increase in runway latency, and by decreased time to escape from a water maze; thus the data are in agreement with the previous results obtained by Thompson (5), by Doyle and Yule (2), by Hockman (3), and by Ader and Belfer (1). However, the main trends are complicated by interactional effects between the prenatal variable and other factors, particularly intensity of pregnancy-stress, sex of the offspring, and parental activity level. The nature of the effects is not easy to pin down because they appear to be specific to the tests used.

It is generally true that activity level of offspring is directly related to amount of prenatal stress, but this relation does not hold for either the runway or the water-maze tests. Again, females show more of an effect for activity level, but males show more effect on the runway test. Parental characteristics are also of importance. Of *S*s in the three groups used, offspring from medium-active parents yield the most ambiguous results in all three tests.

It is clear that, while we can confirm the general proposition that pregnancy-stress alters offspring behavior characteristics and can implicate a number of variables contributing to this result, we cannot (at present) make any specific statements as to the exact nature, direction, and magnitude of changes they can produce. Accordingly, future research must attempt to assess more precisely the influences of the parameters. Exact information about them should add to our understanding of the process of early development.

E. Summary

Twenty female rats, divided into three groups according to open-field activity level, were mated to 20 males also so divided: high to high, medium to medium, low to low. Following conception, the experimental animals were given either high- or low-intensity anxiety in an avoidance-conditioning situation. Intensity was defined in terms of shock level, number of conditioning trials, and number of avoidance trials. Maternal activity level was recorded during pregnancy. Control and experimental offspring (cross-fostered at birth) were tested at 90 days for open-field activity, under nonstress and stress conditions, runway performance with food incentive, and water-maze performance. Data show the following: (*a*) maternal activity during pregnancy shows a

general decline proportional to the amount of stress given; high- and medium-active experimental females show a higher overall activity level than do corresponding controls, but low-active experimental animals have a lower level than low-active control animals. (*b*) Experimental offspring show effects on all tests given. The extent and direction of effects are dependent in complex ways on the sex of the animal, parental activity level, and intensity of maternal stress. No simple postnatal effects were found.

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THE EFFECT OF OVERTRAINING ON A NONREVERSAL SHIFT IN *OCTOPUS**[1]

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A. INTRODUCTION

In an earlier experiment (4), the present authors found that reversal learning in octopus could be facilitated by overtraining on the initial discrimination. The effect occurred, however, only if the discrimination involved irrelevant cues. Nonovertrained animals were as fast as overtrained animals in learning the reversal of a successive brightness discrimination, but the presence of an irrelevant cue (either position or orientation)—while having no effect on reversal learning of overtrained animals—significantly hindered nonovertrained animals. One explanation of the results is that overtraining causes animals to switch-in the relevant analyser more firmly (5). During reversal, therefore, overtrained animals will continue to respond in terms of the relevant cue, while nonovertrained animals will switch-out the relevant analyser and respond to other, irrelevant cues. Alternatively, it might be assumed that overtraining directly reduces animals' tendencies to respond to irrelevant cues, by eliminating error factors (1).

One way of testing between these alternatives is as follows. Animals are trained to one of two levels of mastery on a discrimination problem. Instead of learning the reversal, they are then shifted to an independent discrimination (a nonreversal shift). Error factors such as position cues are common to both problems; thus if the overtraining reversal effect is due to error-factor elimination, overtraining should also facilitate nonreversal-shift learning. On the other hand, each problem involves a different relevant cue; thus if overtraining causes animals to switch-in the relevant analyser more firmly, it will hinder nonreversal-shift learning. Two experiments (2, 3), utilising brightness and orientation discriminations, have shown that rats are hindered in such a situation. The purpose of the present experiment is to discover

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whether this holds for octopuses with an orientation and a shape discrimination.

B. METHOD

1. *Subjects*

The *S*s were 16 *Octopus vulgaris* Lamarck obtained from the Bay of Naples and weighing between 250 and 500 gms. They lived in individual "Eternit" tanks with a brick "home" at one end.

2. *Shapes*

Scale diagrams of the four shapes used are shown in Figure 1. The area of the ⊔ shapes was 26 square cm. The area of the Λ and M shapes was 24.5 square cm.

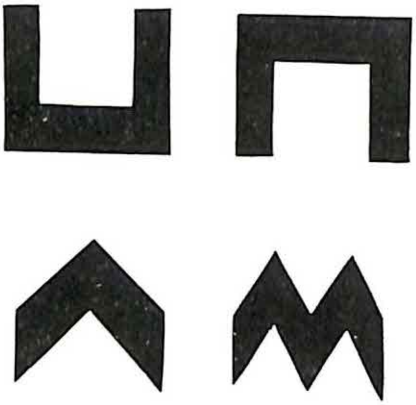

FIGURE 1
THE TRAINING SHAPES

3. *Simultaneous Discrimination Training*

The *S*s were trained by a simultaneous method following, in most respects, that used by Sutherland, Mackintosh, and Mackintosh (6). The tank was divided into two sections by a black Perspex screen with a centrally placed opening covered by a transparent door. At the beginning of each trial, *S* was detained behind this screen while the shapes were lowered into the water, one shape on each side of a partition that protruded 30 cm into the center of the tank. After five seconds, the door in the screen was raised and *S* could swim out to make a choice. The criterion of response was that *S* should grasp one of the shapes. A correct choice was rewarded with a piece of sardine, an incorrect choice was punished with an eight-volt electric shock delivered with a probe.

Before discrimination training began, *S*s were trained to attack sardine and were then given two days' pretraining with the positive shape. On Day 2, 10 further trials were given with the partition as well. On five trials, the shape was shown on the left and on five it was shown on the right. If *S* failed to attack within 20 seconds of the door being raised, it was lured out with a piece of sardine. If necessary, this procedure was also followed during training.

During training, 10 trials were given daily at 15- to 20-minute intervals. There were two main differences between the procedure employed for the present study and that used by Sutherland, Mackintosh, and Mackintosh. In the first place, the latter authors used a simple partition between the shapes that were displayed against the tank side. The present authors used a screen the same size as the short end of the tank. The screen was made of matt black formica, with the partition projecting centrally from it. It acted as a background and provided better contrast between shape and background than hitherto has been used in octopus experiments. The second difference was that the present authors used a modified-correction procedure. After an incorrect choice, shapes and partition were removed, then two minutes to five minutes later, the partition was replaced with only the positive shape in position, and *S* was rewarded when it attacked.

4. *Experimental Design*

In Stage 1, all *S*s were trained to discriminate between ⊔ and ⊓: half with ⊔ positive, half with ⊓ positive. *S*s were trained to a criterion of 75 per cent correct responses over two consecutive days. After reaching criterion, eight *S*s were given 100 overtraining trials.

In Stage 2, all *S*s were trained on the Λ versus M discrimination: eight with Λ positive, eight with M positive and with half of each of these subgroups initially having been trained with ⊔ positive and half with ⊓ positive. Training was continued until a criterion of 80 per cent correct responses over two consecutive days was reached.

C. RESULTS

The results are shown in Table 1. Two measures, trials and errors to criterion, are given for both Stage 1 and Stage 2.

1. *Stage 1*

Overtrained and nonovertrained groups were closely matched on both trial and error measures. The effect of the direction of training was not significant.

TABLE 1
MEAN TRIALS AND ERRORS TO CRITERION DURING STAGE 1 AND STAGE 2

Groups	Stage 1 Trials to criterion	Stage 1 Errors to criterion	Stage 2 Trials to criterion	Stage 2 Errors to criterion
Nonovertrained	56.25	19.125	53.75	15.75
Overtrained	55.0	19.375	78.75*	29.375*

* One overtrained *S* failed to learn. For statistical purposes, it was treated as having reached criterion in 100 trials.

The overall score during overtraining of 75.375 per cent correct responses indicates that the asymptote of performance had already been reached by the end of initial training.

2. *Stage 2*

Analyses of variance were performed on both trial and error scores. In both analyses, the only significant effect was that of overtraining. For trials, $F = 8.62$ ($df = 1, 11$; $p < .05$); for errors, $F = 13.53$ ($df = 1, 11$; $p < .01$). In neither analysis, was there a significant interaction ($F < 1$) between the directions of training in the two stages.

D. DISCUSSION

The results show that, in octopuses, overtraining on an orientation discrimination impedes the learning of a shape discrimination. It seems impossible to explain this finding in terms of Harlow's error-factor theory (1). The interpretation here offered is that, in octopuses as in rats, the mechanism underlying discrimination learning consists of two processes: animals must learn first to switch-in the analysing mechanism that will detect the relevant differences between the stimuli and, secondly, to attach responses to the outputs of the analyser. On the assumption that overtraining strengthens the first process, it follows that (since to learn the second discrimination, animals must switch-out the analyser relevant to the first) overtrained animals will be hindered.

This account assumes that the two discriminations involve separate stimulus dimensions. The stimuli were chosen in the hope of ensuring such dimensions, but until one knows the dimensions along which an animal classifies stimuli, such a result cannot be guaranteed *a priori;* hence the importance of training animals in opposite directions and of using a factorial design. If both pairs of stimuli had varied along a single dimension, then preferences established between one pair should have transferred directly to the second pair, and a significant interaction should have appeared between the directions of training in the two stages. Because there was no evidence for such an interaction, it is safe to assume that different dimensions were involved.

E. SUMMARY

Sixteen octopuses were trained on an orientation discrimination, half of them being trained to criterion only, the other half being given 100 overtraining trials. Then they were shifted to a shape discrimination. This discrimination was learned significantly faster by nonovertrained animals as compared with overtrained animals. Because octopuses as well as rats benefit from overtraining when learning a reversal, the present results indicate that overtraining on one discrimination has an effect on the learning of a second discrimination that is determined by the relationship between the dimensions involved in the two discriminations.

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BOOKS

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